MILITARY AVIATION

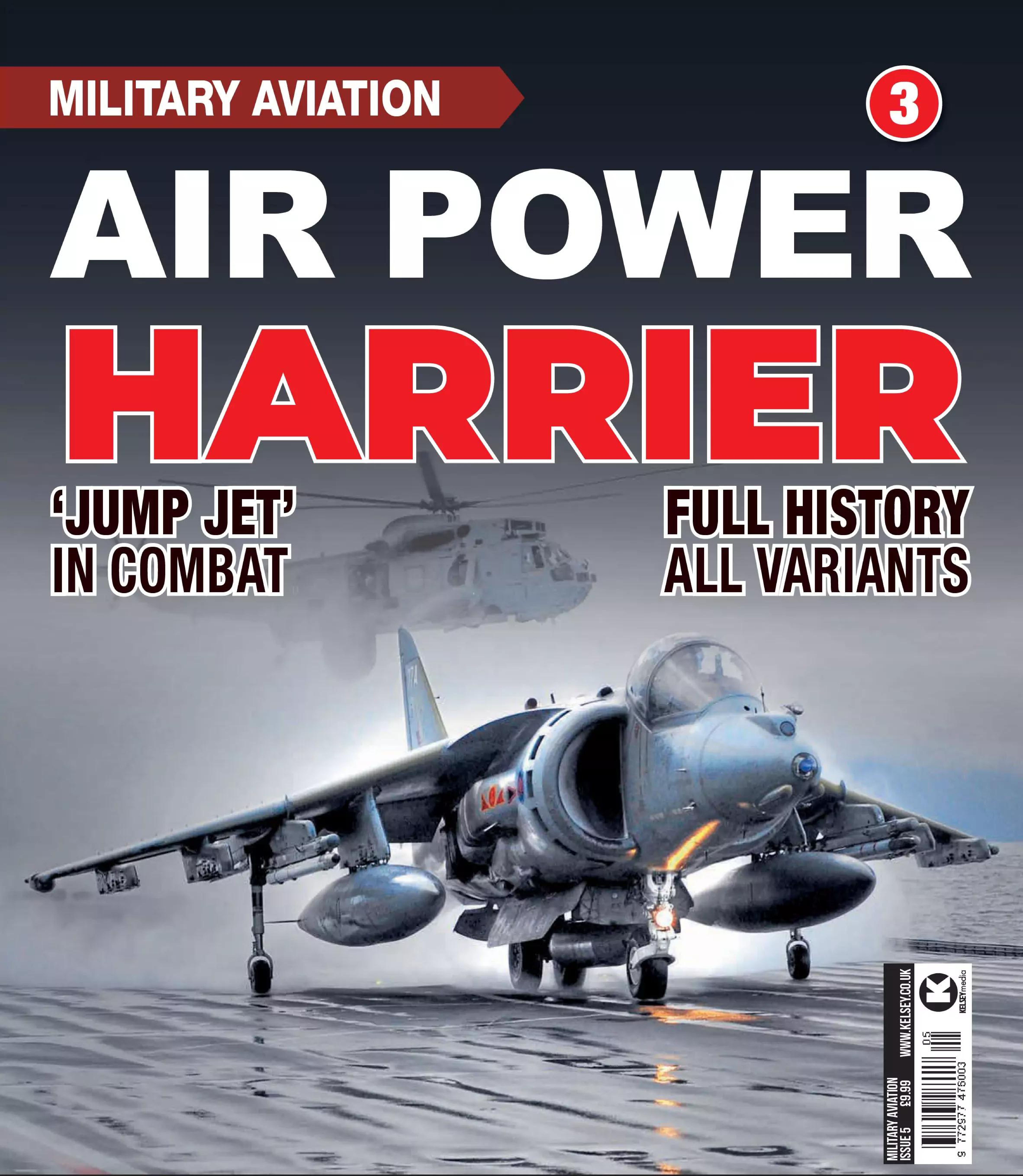
3

AIR POWER

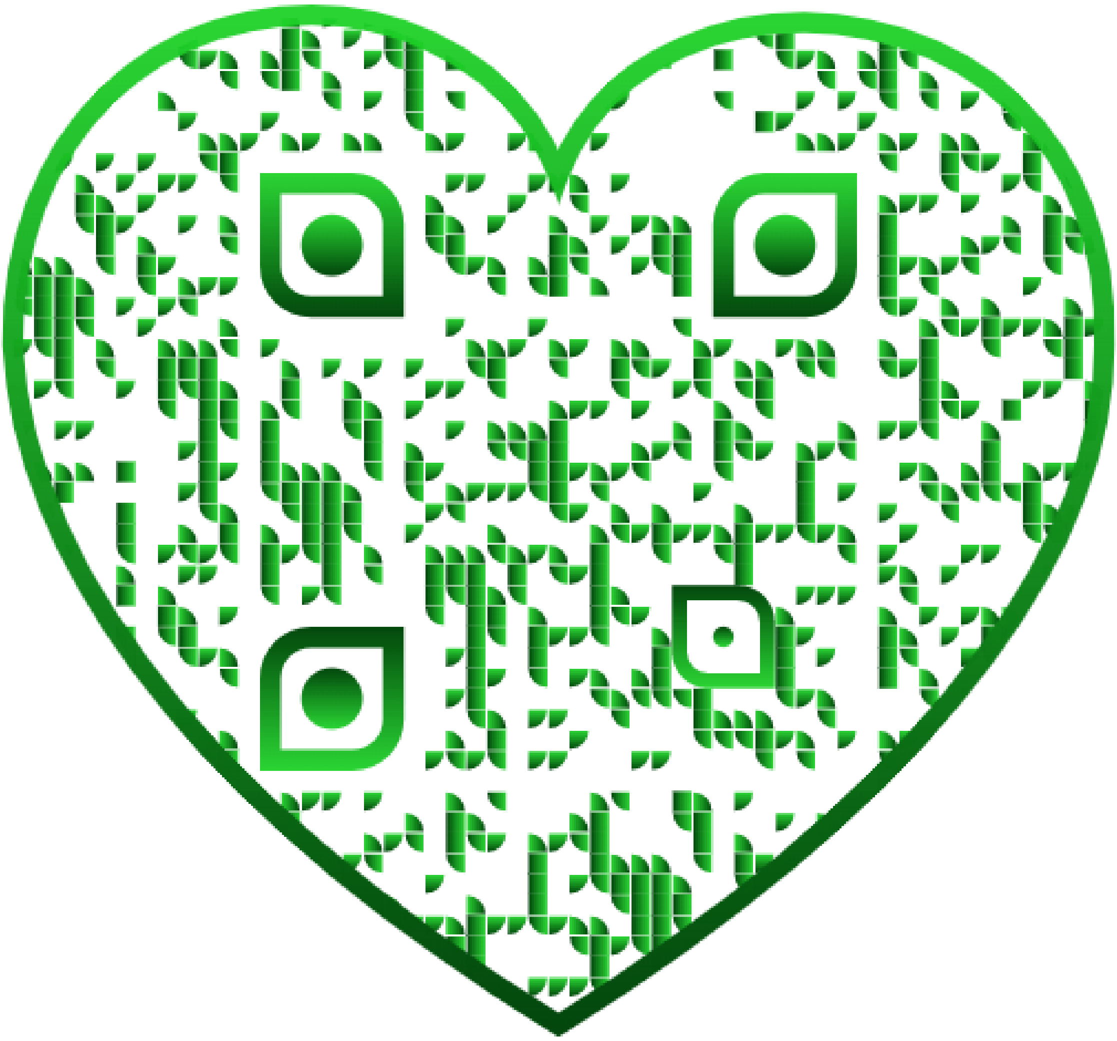
HARRIER

'JUMP JET' IN COMBAT

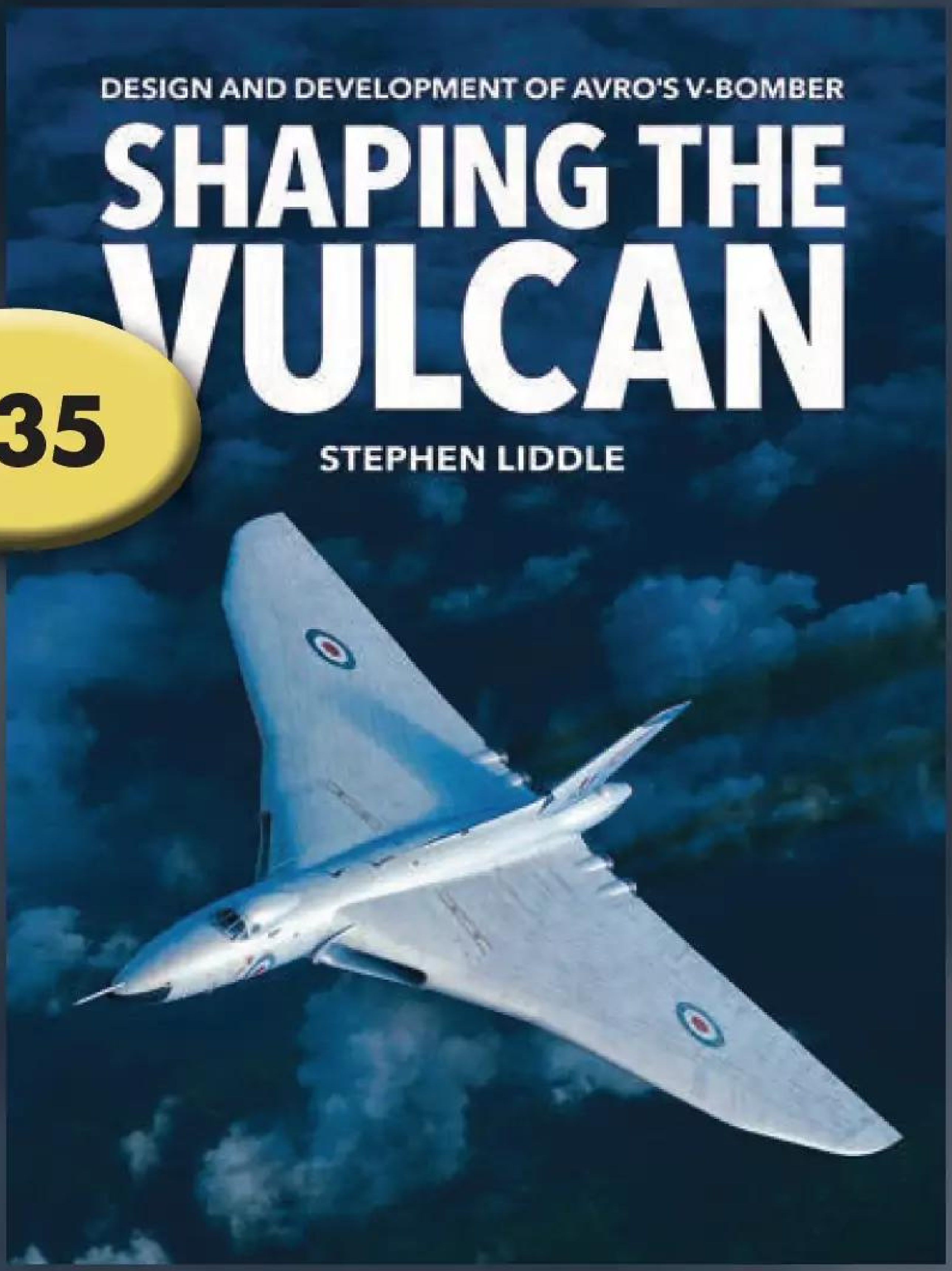
FULL HISTORY ALL VARIANTS



MILITARY AVIATION
ISSUE 5 £9.99
WWW.KELSEY.CO.UK
KELSEYmedia



YOUR NEXT AVIATION READ IN HARDBACK


DESIGN AND DEVELOPMENT OF AVRO'S V-BOMBER
SHAPING THE VULCAN
STEPHEN LIDDLE

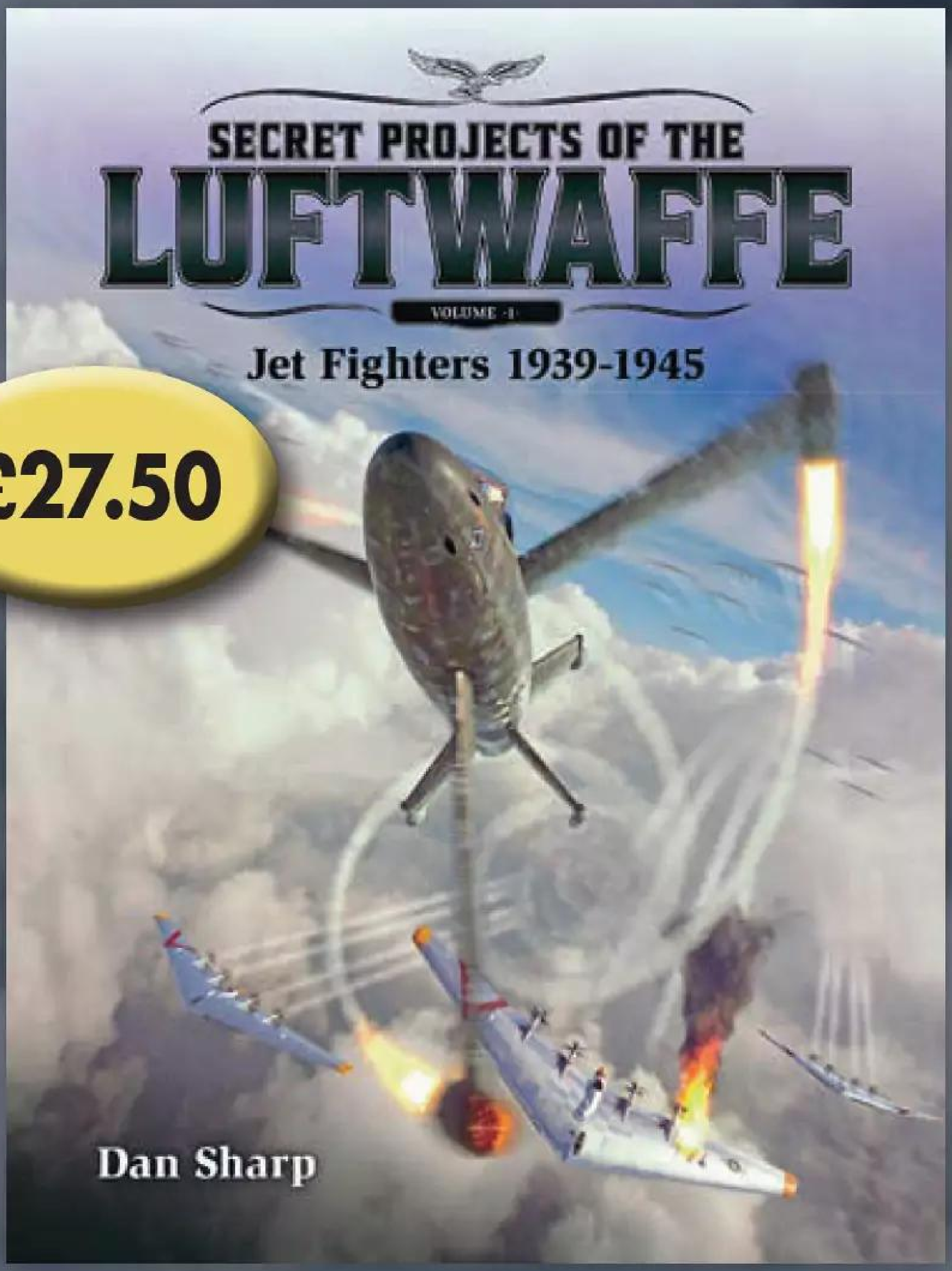
£35

THE INVISIBLE CAMPAIGN
BOMBER COMMAND GARDENING OPERATIONS 1940-1945
JANE GULLIFORD LOWES
FOREWORD BY JAMES HOLLAND

£25

CALUM E. DOUGLAS
THE SECRET HORSEPOWER RACE
WESTERN FRONT FIGHTER ENGINE DEVELOPMENT

£35


SECRET PROJECTS OF THE LUFTWAFFE
VOLUME 1
Jet Fighters 1939-1945
Dan Sharp

£27.50

For more details or to order visit:

mortonsbooks.co.uk or call +44(0)1507 529529

Hotline open Monday to Friday 8.30am-5.00pm. Calls charged at your standard network rate.

Inside the well-appointed cockpit of an Italian Navy AV-8B Harrier II Plus on the deck at sea. **Luigino Caliaro**

Contents

ROYAL NAVY
ROYAL NAVY
251
252
253
N
N

8 Genesis of a concept
14 The Hawker P.1127
19 Kestrel, P.1154 and the Harrier
23 The Harrier GR.1 to GR.3
27 Frontline Harrier Belize
30 The first ship-borne Harriers
34 Eagles and Harriers
40 Battle Diary 1
48 Over the Falklands
58 A Yank in Her Majesty's Service
69 Brit/Yank Lexicon
71 Sea Harrier FA.2
75 The big wing birds
80 Battle Diary 2

N
ROYAL NAVY

87 Battle Diary 3
89 The trainers
92 Marine AV-8Bs over Iraq
99 Harrier abroad
104 Last Harrier down
112 Farewell to the Harrier

MILITARY AVIATION
AIR POWER

Kelsey Publishing Ltd.

Published by Kelsey Publishing Ltd, The Granary, Downs Court, Yalding, Kent ME18 6AL

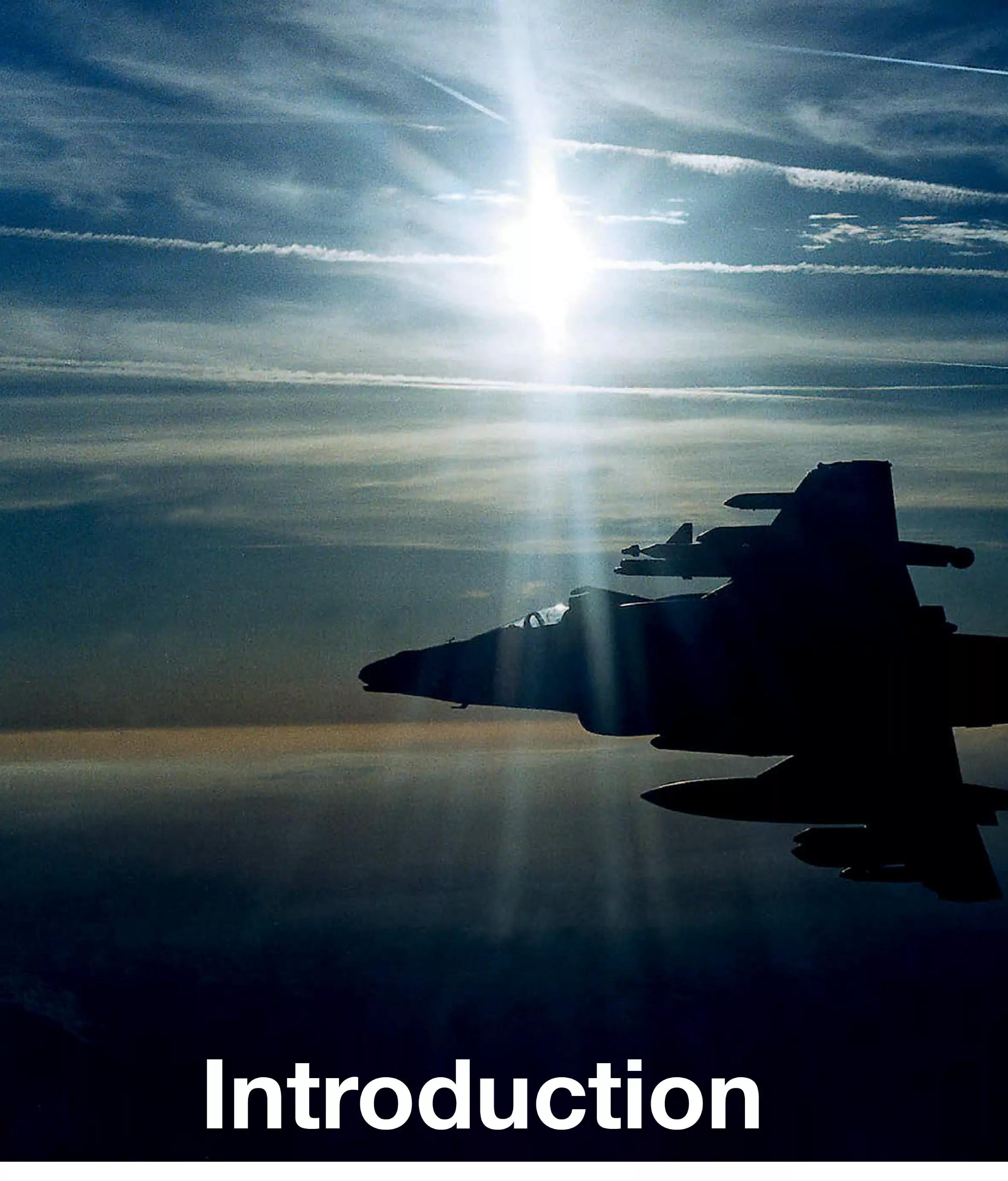
All rights reserved. No part of this magazine may be reproduced, scanned, transmitted in any form including electronic, mechanical or photocopying or by storage of material, without prior permission from the publisher. All effort has been made to ensure content is correct. The publisher, editor and author cannot accept any responsibility for any errors in articles. The views expressed are not necessarily those of the publisher, editor or author.

Editor: Tim Callaway
Contributors: Malcolm Clarke, Steve Deaux, Norm DeWitt, Douglas C. Dildy, Keith Draycott, Luigino Caliaro, David Oliver, François Prins, Constance Redgrave, Warren Thompson, Adam Tooby, Joe Walsh, Robert I. Winebrenner
Production Director: Steve Wright
Retail Sales Director: Steve Brown
Design: Druck Media

Kelsey Publishing Ltd.
Registered No. 02387149

Kelsey Media is one of the fastest growing media businesses in the UK. Founded more than 30 years ago, the independently owned publisher has rapidly grown from a traditional print publisher into a pioneering media network that reaches millions of people every day in ways that are relevant to them. At last count, Kelsey Media's portfolio consisted of more than 80 multi-media brands.

KELSEY media



Introduction

I started writing about the Harrier years ago. I was captured by the unusual capabilities of the aircraft, the very oddness that is the essence of a Harrier in flight. So many great engineers and aviation pioneers tried and failed to create a working V/STOL fixed wing aircraft, then in the middle of this struggle, a Frenchman is introduced to two Englishmen by an American … and against all odds they succeed, not just succeed, but succeed brilliantly. It sounds like a set-up for a joke, but the 'punchline' was the world's first operational single engined fixed wing vertical/short take-off and landing aircraft, the Harrier.

The important part of that description is single engined. When Michel Wibault (the Frenchman) introduced his concept to Sir Stanley Hooker and Gordon Lewis (the Englishmen) through Colonel John

Bye bye beautiful. All good things must come to an end. **BAE SYSTEMS**

Driscoll (the American), what was to emerge was the first production model engine capable of providing vertical and horizontal thrust in a single unit: the Bristol/Rolls-Royce Pegasus.

What this aircraft and engine achieved together is simply incredible. Overseas sales brought millions of pounds into the UK. Wars were won – one on its slender wings alone. Innocent civilians were protected from harm by despotic regimes. It was developed by the US and Britain into an entirely new machine in effect, forging strong engineering links and military friendships between the countries. It was one of the most potent and successful frontline aircraft in service in the world, subject to upgrades and enhancements that kept it at the cutting edge for decades after the prototype first flew in 1960.

In writing the Harrier story, I discovered that the whole programme hung on the knife edge of a political decision so often it was ridiculous, especially given the capabilities of the aircraft and its obvious applications. Some may consider that naive, that all expensive projects have a political dimension that is inescapable in the modern world.

The last RAF or Royal Navy Harrier flew in December 2010, yet the aircraft had only recently been subject to a £500 million upgrade that was to keep it in service until 2018, to retire when the F-35 entered service. A £574 million maintenance contract had been signed in 2009, and the £84 million Tactical Information Exchange Capability upgrade had flown for the first time on June 29, 2010, with service clearance trials ongoing, when suddenly the whole fleet was scrapped.

The reason was to reduce costs as part of the Strategic Defence and Security Review (SDSR)and due to its 'limited capabilities'. The limited capabilities referred to included the removal of the 25mm Aden gun pods from these aircraft. Again, a political cost saving decision, but one which prompted a Parachute Regiment Major in Afghanistan to refer to the gun-less air support his position was receiving as "utterly, utterly useless". So, in effect, one political decision crippled the aircraft.

The end of the Harrier was the end of VSTOL in the UK forces for many years – prior to the declaration of the F-35 as combat-capable in January 2019. For almost a decade, the UK had no aircraft carrier capability and no close support aircraft. It seemed as though the lessons of the Falklands had been completely forgotten.

The missions over Libya as part of Operation Ellamy could have been tailor made for the Harrier Force which would have been a lot less expensive than the types used, in terms of finance, manpower and the damage these operations have done to the Typhoon programme.

Despite the Harrier being retired from UK service early, it would remain in service with the US Marines, the Italian Navy and Spanish Navy well into the 2020s, with the Spanish making plans to keep their going into the 2030s – more than 70 years after the original Harrier's first flight. This sheer longevity is a tribute to the remarkable success of an incredible aircraft.

All best,
Tim

Genesis of a concept

Why vertical take-off and landing?

Being able to lift straight up off the ground has been one of the earliest dreams of flight since man first thought of emulating the birds. Tim Callaway and Norm DeWitt examine the development story of the vertical lift concept, as well as some of the early designs, some of which were very odd indeed...

NAVY
NAVY
CONVAIR

The Convair XFY-1 'Pogo' in vertical flight. **US Air Force**

NAVY
NAVY
CONVAIR

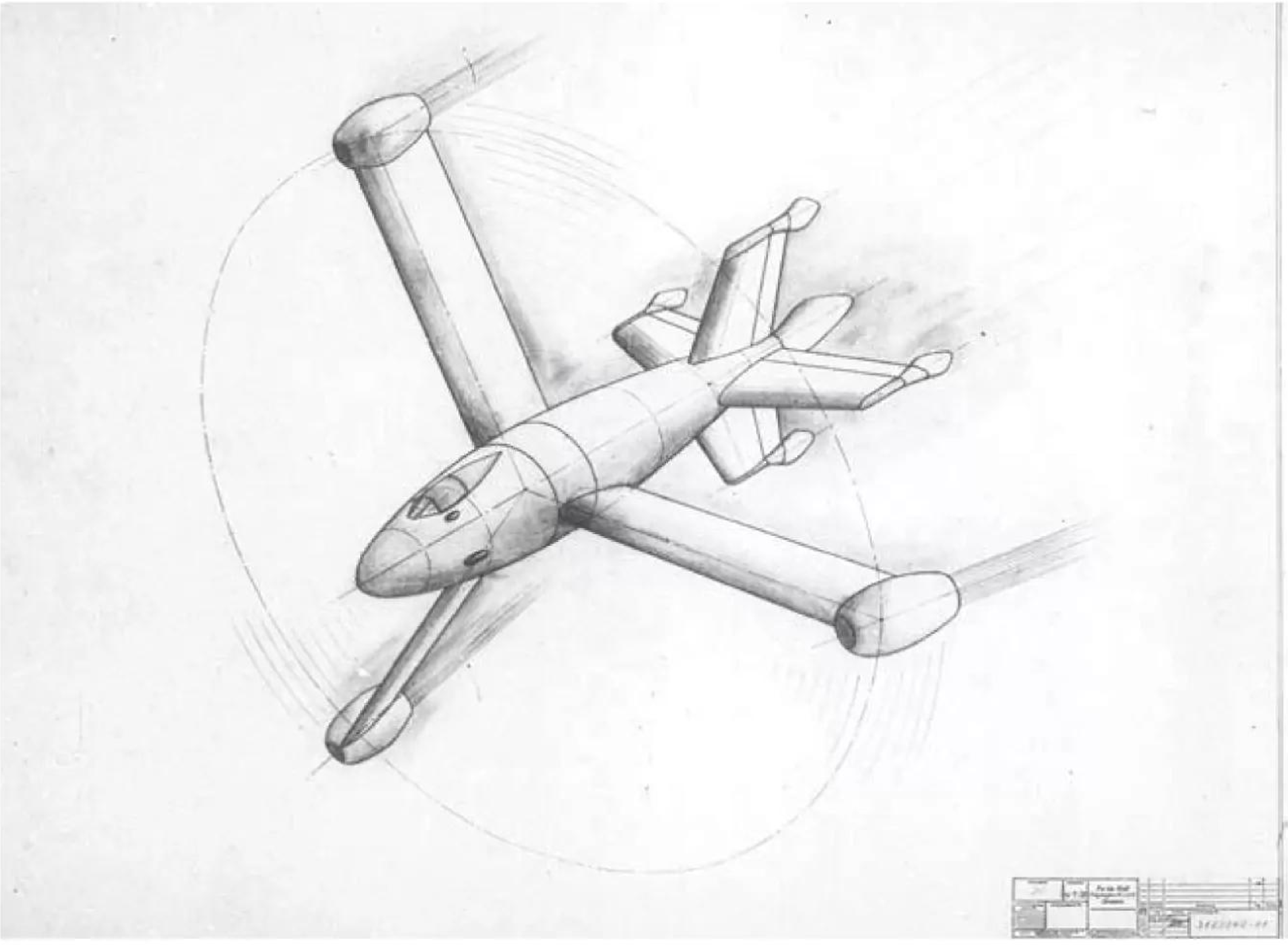
The Convair XFY-1 'Pogo' just after lift-off on an early test flight. **San Diego Air & Space Museum archives**

Since the beginning of aviation, designers have been experimenting with vertical take-off concepts. The idea of being able to fly directly from one city centre to another without the need for large and expensive airports is a civilian application with obvious advantages. For the military, the most vulnerable part of any aircraft to enemy attack is its airfield. An aircraft that did not need a fixed operating base, and could fly from a forest clearing, urban site or a ship's deck would provide air power with both flexibility and survivability. Reaching these desirable goals was to follow two major design streams, one leading to the helicopter, the other eventually to the Harrier.

Today, vertical take-off and landing (VTOL) designs fall into two categories, either tilt-rotor solutions such as the Osprey or vectored thrust designs such as the Harrier and F-35B. The tilt-rotor concept combines the advantages of the helicopter's rotors with the speed and range of a fixed wing turboprop. The vectored thrust aircraft combines the advantages of high-speed fixed wing jet aircraft with the ability to operate from a small space. In both cases, the aircraft fuselage remains horizontal in vertical flight; it is the engine's thrust line that changes direction to allow vertical as well as wing-borne flight This was not always the case with many of the early concepts for VTOL aircraft.

EARLY GERMAN DESIGNS

As with a number of other cutting-edge concepts in aviation warfare, some of the earliest examples were German, developed during the Second World War. The Focke-Wulf Triebflügeljäger (powered-wing fighter) took the concept of vertical take-off from the rocketry designs of the day (such as the V-2), and was designed to use its four tailplanes equipped with ailerons for manoeuvring, take-off and landing support. Where Focke-Wulf's Triebflügeljäger was



A contemporary drawing of a Focke-Wulf Triebflügeljäger in flight. At rest, the aircraft would sit vertically on its tail. In motion, the wings rotated from the thrust of the pulse jets at their tips, providing both lift and thrust. **DS collection**

radically different was that it featured three rotating blades with a ramjet engine at the tips of each blade. A small rocket motor in each unit would get the ramjets up to operating speed and, once ignited, they would then propel the rotating blade assembly for maximum lift and provide forward thrust once under way. The FW's lack of conventional wings meant the blades spinning around the fuselage would also provide the lift and one can only imagine what a challenge operating this aircraft could have proven to be with so many unusual concepts in play.

There could have been additional complications as the wingless FW would have had a nose high balance point of equilibrium between lift and forward motion to maintain level flight, the pilot likely unable to see past the nose in the direction of flight. Also, with experienced Luftwaffe pilots in short supply, there was little chance of something as unusual as the Triebflügeljäger going into production given the hard choices facing Germany late in the war, so the FW's destiny was to be a design exercise.

There were other similar Coleopter designs by Heinkel such as the Lerche (Lark), in which the design solution involved contra-rotating propellers in an annular wing or closed cylindrical wing design. Both the Triebflügeljäger and Lerche remained unbuilt, but similar concepts were to be revived post-war in Europe and America and Focke-Wulf was to be involved in the NATO programme to provide a VTOL strike fighter in the 1960s.

THE FIRST US PROGRAMMES

By the late 1940s, the VTOL concept had begun to gain traction with the US armed forces. Contra-rotating propeller designs as used in the Rolls-Royce Griffon powered Spitfires and Seafires had advantages in efficiency, but the real advantage was that with the contrarotating prop there was a little torque transmitted to the airframe. In a vertical application this was critical, as during take-off any VTOL aircraft is vulnerable to such forces. As a direct result, the designs that were to emerge in the early 1950s from Convair and Lockheed had the three-blade contra-rotating prop feature in common. Both design solutions were in response to the same challenge issued by the US Navy, the contracts having been awarded in 1951.

The Convair XFY-1 'Pogo' was a delta wing design, its vertical fins forming the other two support points for take-off or landing. The plane was tiny, with an overall length of 23ft and a wingspan of 28ft. San Diego's Convair made the claim of having the first operational VTOL aircraft and it made a number of fully operational vertical take-offs and landings in August 1954.

DESIGN PROPOSALS FOR NATO BMR-3

AC/169a Mach 2 VSTOL fighter

France – Dassault Mirage III-V
Netherlands – Fokker-Republic D.24 Alliance
UK – BAC/Vickers 583
UK – BAC/Vickers 584
UK – BAC/Vickers 585
UK – BAC/English Electric P.39
UK – Hawker P.1150/3
UK – Hawker P.1154

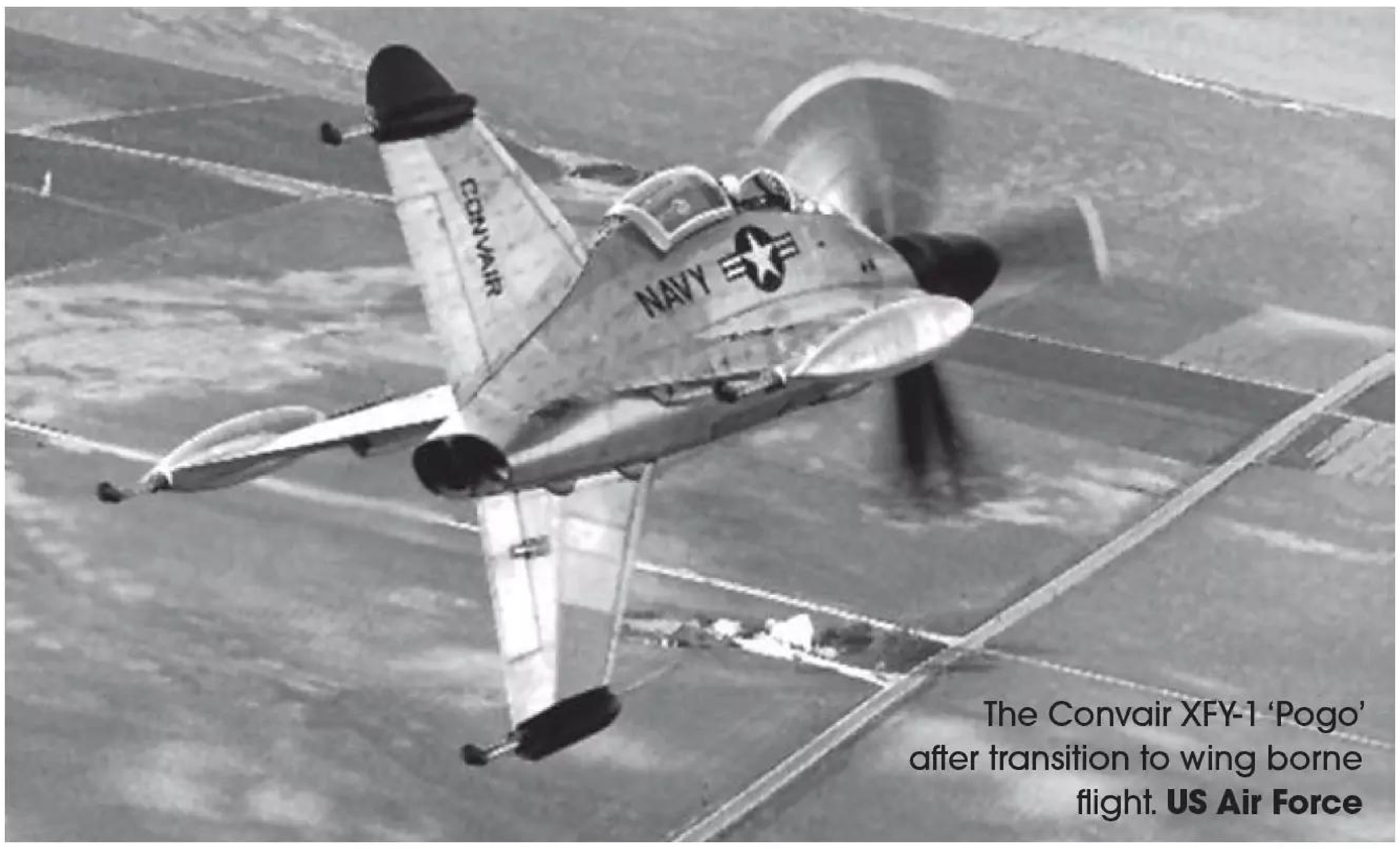
AC/169b Subsonic VSTOL fighter-bomber

France – Breguet Br.122
France – Nord N.4400
Germany – EWR VJ.101
Germany – Focke-Wulf Fw.1262
Italy – Fiat G.95/4
UK – Armstrong-Whitworth AW.406
UK – Shorts PD.45
UK – Shorts PD.49
UK – Shorts PD.56
UK – BAC/English Electric P.39
USA – Lockheed CL-704

However, flying it was not a simple task, as it required highly trained pilots, the Achilles heel for every VTOL programme. The Pogo currently belongs to the National Air and Space Museum but is not currently on display.

For the Lockheed XFV-1, the tail was separate from the wing, providing four tailplanes at a 45-degree angle to the wing surface for take-off and landing support. There was a conventional wing with a minimal wingspan of 30ft; however, the Lockheed at 36ft in length is far less stubby in appearance than the Convair Pogo.

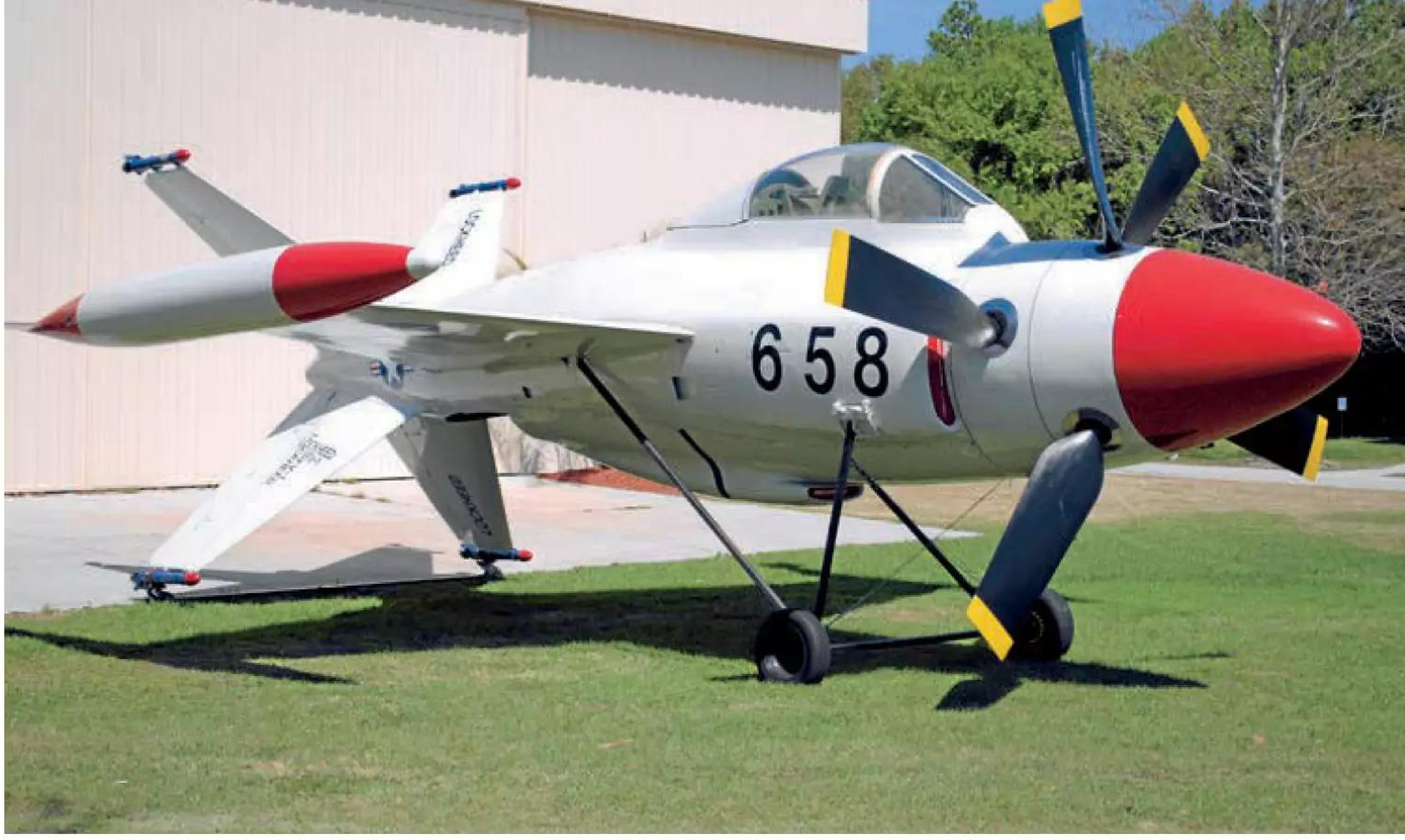
The aircraft as tested was never provided with the anticipated engine, however, and had less power than the Pogo of similar weight. Although it flew numerous test flights going from horizontal flight to vertical hover transitions, none involved vertical take-off or landing. As ➤



The Convair XFY-1 'Pogo' after transition to wing borne flight. **US Air Force**

Ryan X-13
Vertijet

Close-up of the Ryan X-13 Vertijet logo on the nose of the aircraft. **Norm DeWitt**



The Lockheed XFV-1 on display at the Florida Air Museum in Lakeland, Florida. **Norm DeWitt**

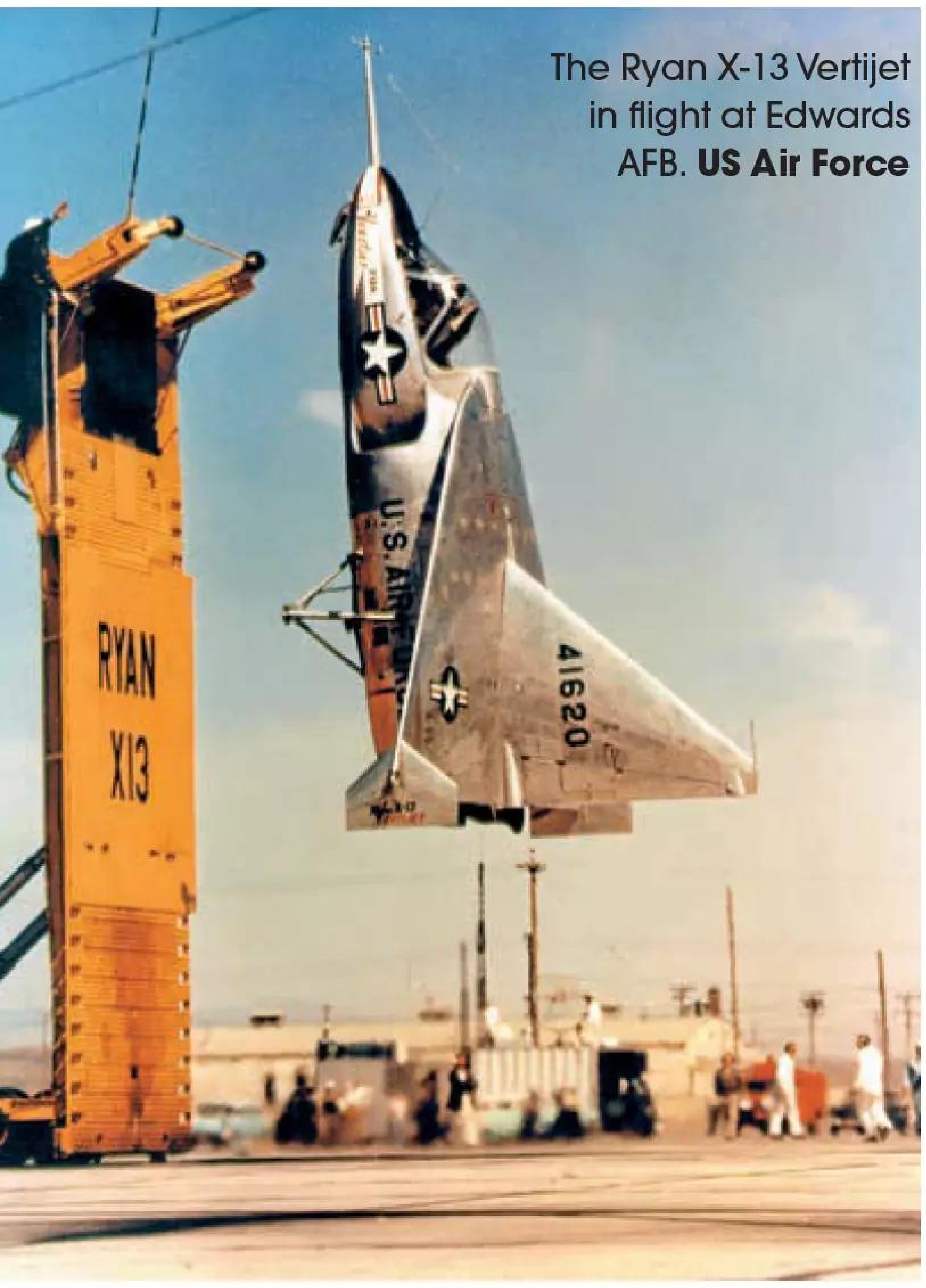
such, it never truly achieved the basic design concept for a VTOL application, and the project was abandoned soon after.

One of the two prototypes built is currently on public display, having been the recipient of a 6000-man-hour restoration at the Buehler Restoration Center of the Florida Air Museum in Lakeland, Florida.

Perhaps the biggest problem with the first generation of American VTOLs was that they were of staggeringly insufficient performance given the capabilities of mid-1950s jet fighter aircraft. Both the Convair and Lockheed designs would have proven hopeless in air-to-air combat, and the ship defence role that was their entire reason for being. Clearly if a VTOL application was going to be able to have any chance in a clash of aircraft, it had to be jet powered as well.

THE VERTIJET

This next generation of VTOL fighter had originated from another San Diego area company, in this case Ryan Aeronautical. Ryan's solution was the X-13 Vertijet, which evolved from years of study for the US Navy in jet-powered VTOL applications. The contract to build the plane came from the US Air Force in 1953. The resultant aircraft was even smaller than the Pogo, only 23ft 5in in length with a minimal wingspan of 21ft. Eventually the tiny X-13 managed to achieve all the parameters that would make for a successful VTOL aircraft, transitioning from horizontal to vertical flight, while also achieving vertical take-offs and landings.



The Ryan X-13 Vertijet in flight at Edwards AFB. **US Air Force**

The 10,000lb of thrust from the Rolls-Royce Avon RA 28-39 was certainly sufficient for a 7313lb aircraft to attain vertical flight. However, the published estimated top speed of approx. 483mph was insufficient, and even that number was probably optimistic. As noted by one of the museum staff while referring to the published specifications: "That was probably the wish list."

Although the best performing of the VTOL designs, the Vertijet was as useless in combat vs state-of-the-art fighters as with previous attempts, and the project was abandoned.

The first built of the two Ryan prototypes is on long term loan from the National Air and Space Museum in Washington DC, and was formerly on display at the San Diego Air & Space Museum. For the past year and a half it has been relocated to its Gillespie Field facility in nearby El Cajon.

As VTOL aircraft go, it is far easier to transport the Vertijet, which the staff of the San Diego museum know from experience. "We were in talks to try and get the (Convair) Pogo, but it's not like this one (Vertijet) where the whole wing comes off. We were able to bring the X-13 out here on our 30ft flatbed trailer. With the Pogo, there is no easy way to disassemble it, no easy way to transport it."

As a result, hopes of displaying the two San Diego-built VTOLs designs at their hometown will not be achieved for now. The other remaining Ryan X-13 Vertijet is currently on display at the US Air Force Museum in Dayton, Ohio.

EUROPEAN PROGRAMMES

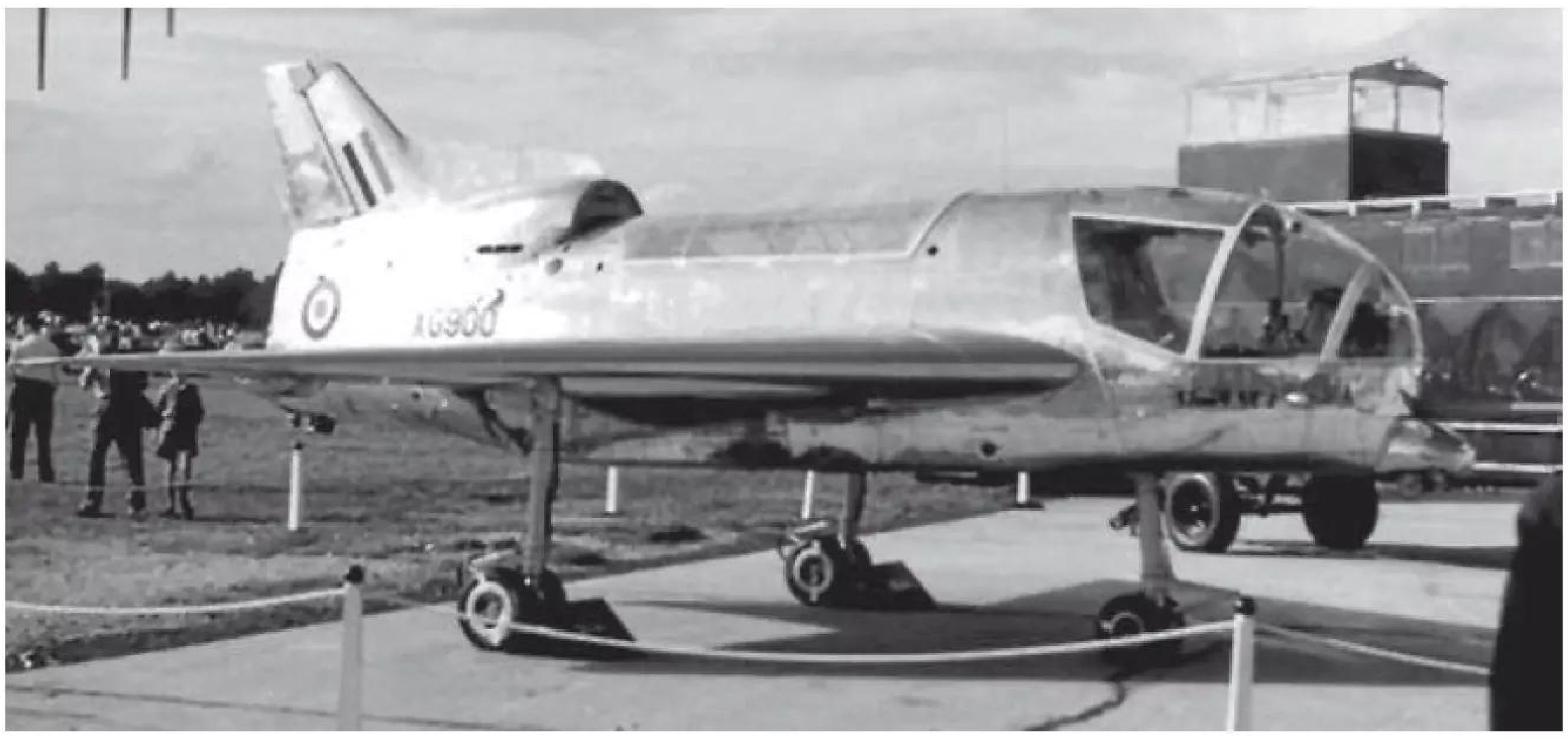
At the same time as these developments in America, other countries were developing interests in vertical take-off aircraft. In France, the Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, or SNECMA, began experimenting with a VTOL tethered model powered by a small pulse jet engine in 1954. The success of these trials led to the design of the C.400 series of jet powered testbeds called the Atar Volants.

Three models were built starting in 1954, the P1, a remotely controlled version, followed by the P2 and P3 manned versions with an ejection seat mounted above the air intake to the jet engine. The P2 was to successfully demonstrate vertical take-off at the Paris Air Show. It was essentially a vertically mounted Atar 101 DV turbojet of 6394lb (2900kg) thrust, fitted with a vectoring nozzle and surrounded by an annular fuselage containing gyroscopically stabilised control systems and fuel tanks. The P2 made its first tethered flight on April 8, 1957, followed by the first free flight on May 14, 1957.

Over 120 flights were made assessing the effects of the control systems, torque effects of the jet engine and wind on the aircraft, which only had an endurance of just over four minutes.

The next aircraft was developed still further. The P3 was fitted with a 7716lb thrust (3500kg) Atar 101E turbojet and a tilting ejection seat inside an enclosed cockpit. After a series of trials, the data gathered from the Atar Volant programme was used to design an aircraft intended to transition between vertical and horizontal flight, the C.450-01 Coleoptere. This was similar to the P3, but had an annular wing to generate lift in forward flight. The prototype made its first flight in May 1959, using a pneumatic system to deflect the jet exhaust for directional control. Sadly, this highly unusual prototype was to crash in July the same year, and the entire programme was discontinued.

In Britain, official interest from the Air Ministry in vertical take-off aircraft led Rolls-Royce to begin development of a vertical lift jet engine, the RB.108, producing 2000lb (907kg) of thrust. In 1954, the Ministry of Supply then issued



The Short SC.1 XG900 at the Farnborough Air Show in 1958. **Editor's collection**

NATO'S CONTRIBUTION

The following were the aircraft of the NATO VAK Vertikalstartendes Aufklärungs-und-Kampfflugzeug (Vertical take-off and landing reconnaissance and attack aircraft) programme:

UK (VAK-191A) – Hawker P.1127
Germany (VAK-191B) – Focke-Wulf Fw.1262
Germany (VAK-191C) – EWR-340 (VJ-101D)
Italy (VAK-191D) – Fiat G.95-4

a contract to Short Brothers of Belfast to produce two research aircraft, called the Short SC.1s, the first of which flew on April 2, 1957.

These test aircraft were singular in appearance. They were small, delta-winged aircraft with a fixed tricycle undercarriage and a large glazed cockpit. Power came from no less than five RB.108 engines. Four were mounted vertically in pairs in the fuselage and were able to be tilted slightly fore and aft to provide acceleration and braking. The fifth engine was mounted under the fin in the rear fuselage to provide horizontal thrust for wing-borne flight.

The first flight was made conventionally, with only this fifth engine installed. The first hovering flight, with all five engines installed in the second prototype, took place on May 26, 1958, with the aircraft tethered to the ground. Its first free flight followed in October that year, with the second prototype making the first successful transition from vertical to horizontal flight on April 6, 1960.

The two SC.1s were both fitted with small jet exhausts in the nose, tail and each wingtip, powered by taking 10% of the thrust from the lift engines. These 'puffer' jets provided control in all three axis at low speed, when the aerodynamic controls would no longer function.

The SC.1 programme was to provide invaluable data for the P.1127, the Harrier prototype, particularly in terms of the control systems. The development of the P.1127 will be covered in the following article. Even after a fatal crash in 1963, the second prototype was rebuilt and continued test flying at Boscombe Down until its retirement in 1971. The two aircraft, XG900 and XG905, are both preserved, one by the Science Museum in London, the other by the Ulster Folk and Transport Museum at Cultra in Northern Ireland.

In Germany, during 1959, Heinkel, Messerschmitt and Bölkow formed a joint venture company called Entwicklungsring Süd (EWR). This company was formed to combine the designs of the three member companies for a VTOL fighter. This was aimed at replacing the F-104G Starfighter in Luftwaffe service and later meeting the specification contained in NATO BMR (Basic Military Requirement) 3.

The resultant sleek aircraft was designated the VJ 101C, and was to be the first vertical take-off aircraft to fly supersonically. There were two sets of engines in the airframe, four jets mounted in wingtip pods that could rotate to provide vertical or horizontal thrust, and two more mounted vertically in the fuselage to supplement the lifting thrust from the pods.

Various test rigs were built from 1960 onward to test and develop the control systems; and after the success of these trials, two prototypes were built, the VJ 101C X-1 and X-2. The X-1 made its first hovering flight on April 10, 1963, then made its first successful transition from vertical to horizontal flight on September 20, followed by a programme of 78 test flights. On one of these, on July 29, 1964, the aircraft reached Mach 1.04, breaking the sound barrier even though its six Rolls-Royce RB.145 turbojets were not equipped with afterburners. The X-1 suffered an autopilot failure on September 14, 1964, and crashed.

The second VJ 101C, the X-2, was fitted with a new autopilot and afterburners and made its first successful transition from vertical to horizontal flight on October 22, 1965. Many successful test flights were made, but the entire project was cancelled in 1968 and the intended Mach 2 single-seater, two seat trainer and two seat attack versions, designated VJ 101D, were shelved. The X-2 is preserved and is on display at the Deutsches Museum on Munich.

THE NATO REQUIREMENTS

As already mentioned, in the early 1960s NATO was very aware of how vulnerable airfields were to pre-emptive strikes. As a result specifications were issued by NATO for a VTOL supersonic strike fighter and a transport aircraft able to support it in the field to meet NATO BMR 3 for the fighter and BMR 4 for the transport The specification for the fighter was called AC/169 which was subsequently split into two parts, AC/169a for a fighter capable of Mach 2 and AC/169b for a subsonic fighter bomber, reconnaissance and nuclear capable attack aircraft.

The first was intended as a replacement for aircraft in the Lockheed F-104

➤

The Ryan X-13 Vertijet on a test flight in 1957. **San Diego Air & Space Museum archives**

The Ryan X-13 Vertijet in the San Diego Air & Space Museum's Gillespie Field facility in nearby El Cajon. **Norm DeWitt**

The Short SC.1 XG900 on display in the Science Museum, Kensington, London. **Malcolm Clarke**

Starfighter class, the second was intended to replace aircraft such as the Fiat G.91. A large number of designs and concepts were proposed by American British, Dutch, French, German and Italian companies to answer these requirements.

None of the designs proposed were found to fulfil the needs of AC/169a completely, but in the results released by NATO in May 1962, the Hawker P.1154 won the technical competition and the Mirage III-V won the industrial and work share element, so the two designs were considered joint winners. However, the NATO Committee of Armaments found little common ground for joint development of the two designs in August 1962. The French withdrew from the AC/169a competition shortly after this, and the British cancelled the Hawker P.1154 project in 1965.

The committee did, however, recommend that study continue on the light strike fighter and reconnaissance half of the requirement, AC/169b. The Focke-Wulf Fw.1262 proposal had been declared the winner of this part of the competition, and its specification was used as the basis for the continued evaluation between May and August 1963. This resulted in a joint agreement between Britain, Germany and Italy to develop four designs. The designation VAK, for Vertikalstartendes Aufklärungs-undKampfflugzeug (vertical take-off and landing reconnaissance and attack aircraft), was given to the new designs, and the number 191, as it was a replacement for the Fiat G.91. Each of the four proposals was given a separate letter and the Fw.1262 was built as the VAK 191B.

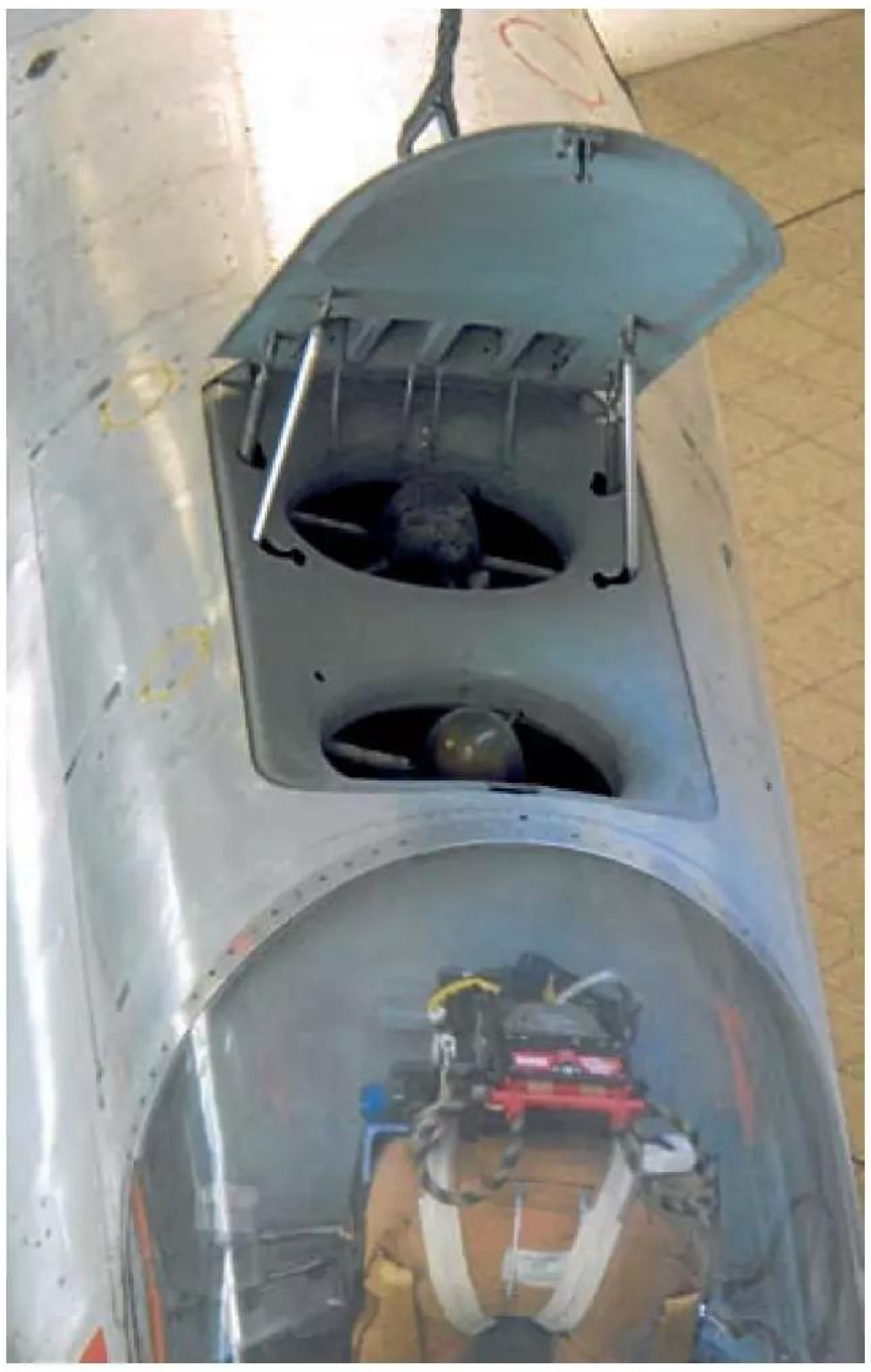
Britain pulled out of the AC/169b development at the end of 1963 for two reasons. Firstly, it was obvious the Hawker design could not win and secondly, the Kestrel joint programme between Britain, Germany and the US was launched in 1963. This was to lead to the Harrier and will be covered in the next article.

INDIVIDUAL DEVELOPMENTS

Germany and Italy continued with the development of the VAK 191B and three prototypes were built by Vereinigte Flugtechnische Werke (VFW), a merger of Focke-Wulf and Weserflug. However, the NATO Armaments Committee cancelled the AC/169b programme in April 1967 and Fiat withdrew its interest at this point, so the three aircraft were produced as technology demonstrators.

The first hovering flight was made on September 20, 1971, at Bremen, and altogether a total of 91 sorties were flown by the three aircraft. The first transition from vertical to horizontal flight and back again was made at Munich on October 26, 1972, and the flying programme ended in 1975.

Again, the VAK 191B had two separate engine systems, causing a severe weight penalty on the aircraft's performance. Two Rolls-Royce RB.162 turbojets were mounted vertically in the fuselage, producing 55,87lb (2534kg) of thrust each. The main Rolls-Royce/MAN Turbo RB.193-12 turbofan engine had four rotatable vectored thrust nozzles, two on either side of the fuselage, and produced 10,150lb (4604kg) of thrust.

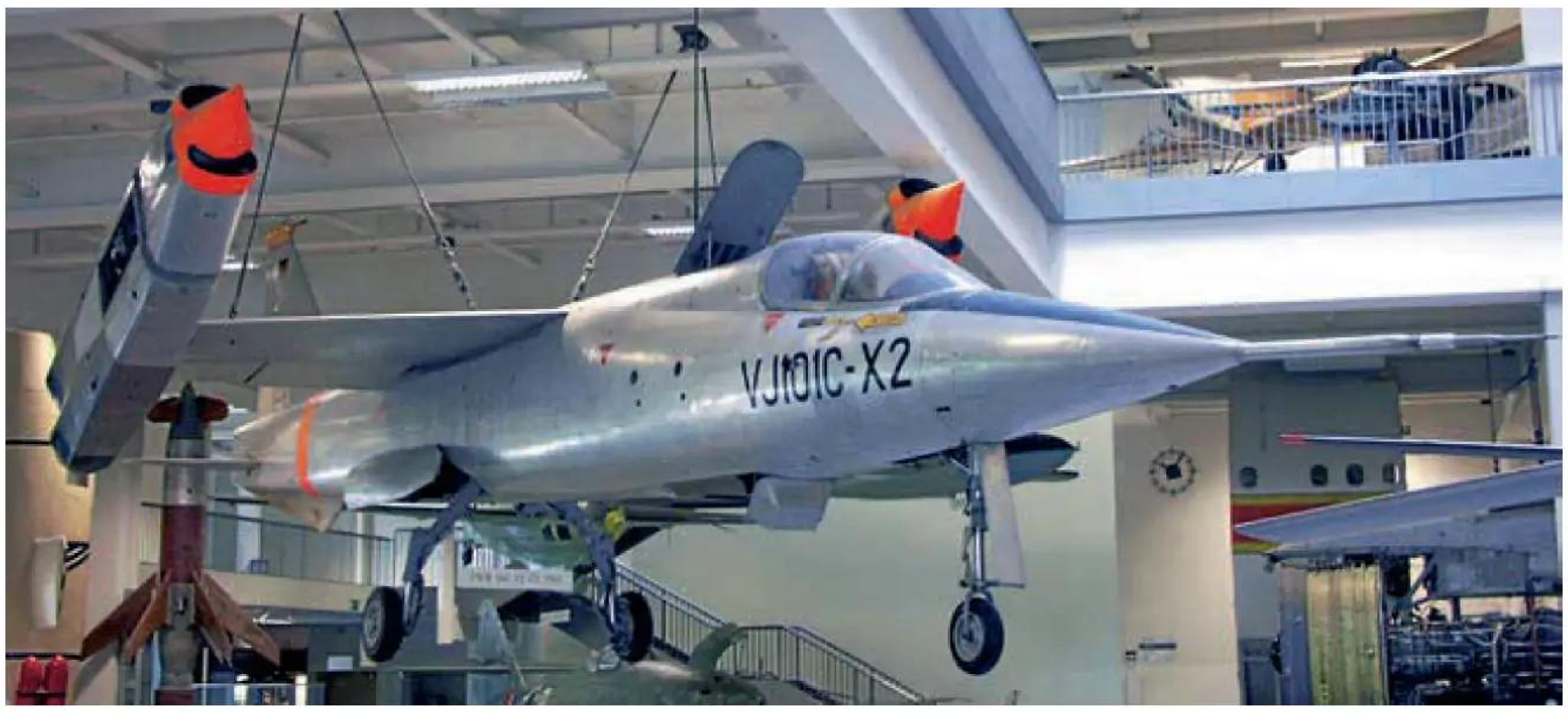


A close-up of the forward fuselage of the VJ 101 C X-2 showing the forward lift engine bay with the door open. **Jean-Patrick Donzey**

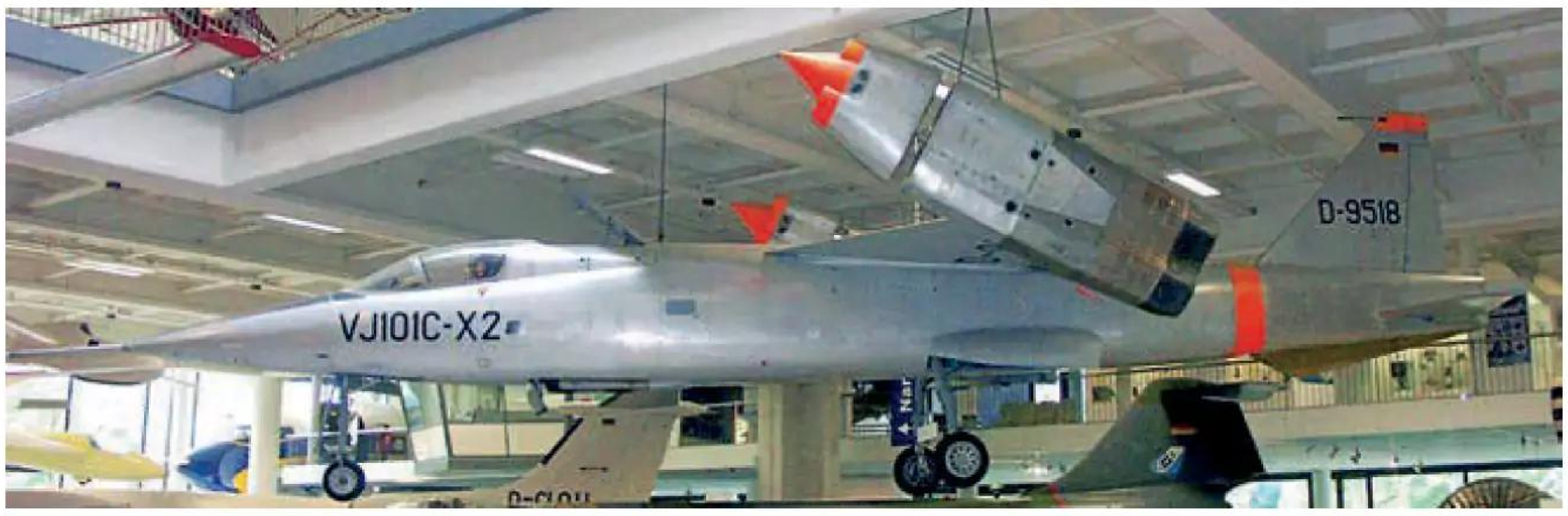
One of the technologies applied to the VAK 191Bs during their test flying was a fly-by-wire control system, the data from which trials was used to produce the control system for the Panavia Tornado. All three aircraft still exist, one in storage with Airbus at Bremen, one as part of the Wehrtechnische Studiensammlung (military technical collection) at Koblenz and the last on public display at the Deutsches Museum Flugwerft Schleissheim at Oberschleissheim, near Munich.

The French entry into the competition, the Dassault Mirage III-V, was also built and tested and was a monster of an aircraft. The Mirage III-V design called for no fewer than eight Rolls-Royce RB.162 lift engines of 3525lb (1600kg) of thrust each, as well as a 13,900lb (6305kg) thrust SNECMA TF104B turbofan for horizontal flight. This last engine was a development of the Pratt & Whitney JTF10, the world's first afterburning turbofan which was to later power the F-111 and F-14 Tomcat. It was tested in a specially modified Mirage, called the Mirage IIIT.

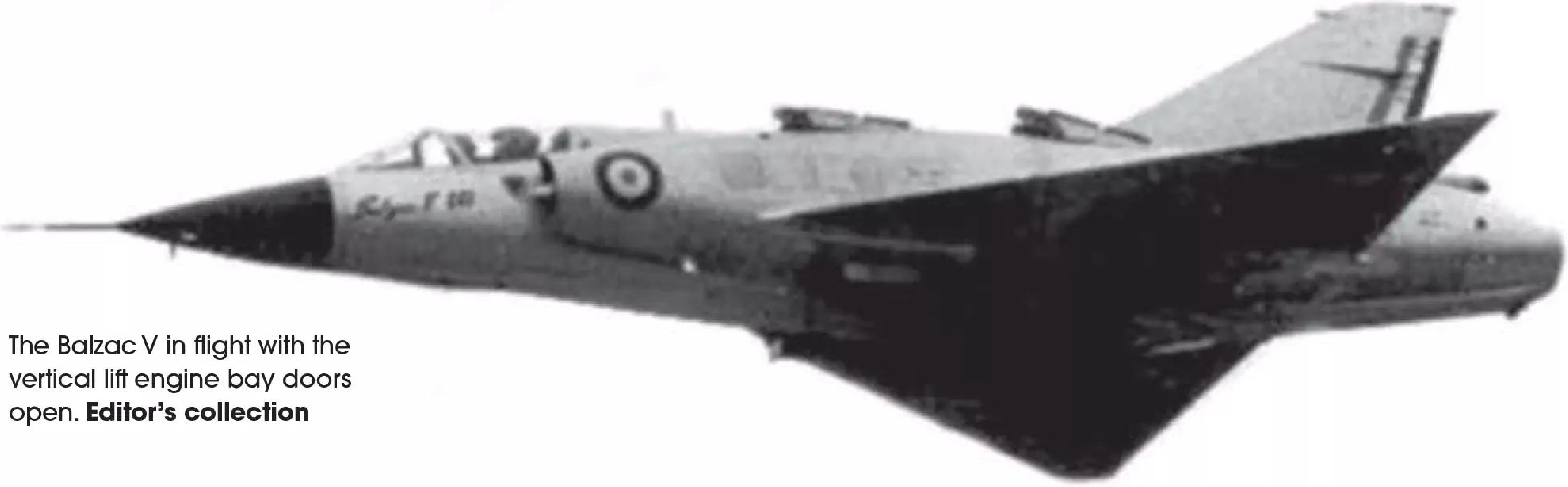
Because the RB.162 lift engines would not be available until 1963, Dassault first built a smaller trails aircraft to test the concept by modifying the prototype Mirage III. Firstly, the prototype's SNECMA Atar



The VJ 101 C X-2 on display in the Deutsches Museum Flugwerft Schleissheim at Oberschleissheim, near Munich. **Jean-Patrick Donzey**



The VJ 101 C X-2 showing the wingtip mounted rotatable engine nacelles. **Jean-Patrick Donzey**


The Balzac V in flight with the vertical lift engine bay doors open. **Editor's collection**

G.2 engine was replaced with a smaller and lighter Bristol Orpheus BOr 3 which produced 4850lb (2200kg) of thrust. On either side of this, mounted in tandem pairs around the centre of gravity, eight Rolls-Royce RB.108-1A lift engines were fitted and provided 2160lb (980kg) of thrust each.

Called the Balzac V, the test aircraft began hovering trials on October 13, 1962, and made its first transition from vertical to horizontal flight on March 18, 1963. Test flying continued until the 125th sortie on January 10, 1964, when the aircraft crashed during a vertical descent and the test pilot, Jacques Pinier, was killed.

The aircraft was repaired and began flying again in February 1965 but was involved in a second fatal crash, again during a descent at low level, on September 8 of that year. As the Mirage III-V had now been completed and test flying had begun, the Balzac was not repaired this time.

At 59ft 5in (18m) in length, the Mirage IIIV was a large aircraft for a fighter, and was similar in design to the other aircraft in the Mirage family. The first prototype of the two Mirage III-Vs built began vertical flight trials on February 12, 1965, but before transition flights began a larger SNECMA TF106 horizontal flight engine was fitted, producing 16,750lb (7598kg) of thrust.

The first successful transition from vertical to horizontal flight was made in March 1966, and flew supersonically, reaching Mach 1.32 later that year. The second prototype was fitted with an even more powerful TF306 afterburning turbofan which produced 18,500lb (8391kg) of thrust. Flight trials with this aircraft began in June 1966 and a level speed of Mach 2.04 was reached in September the same year.

Sadly, the second prototype was lost in an accident on November 28, 1966, which effectively ended the programme. The first Mirage III-V is preserved on public display in the Musee de l'Air at Le Bourget in Paris.

VTOL JET TRANSPORT

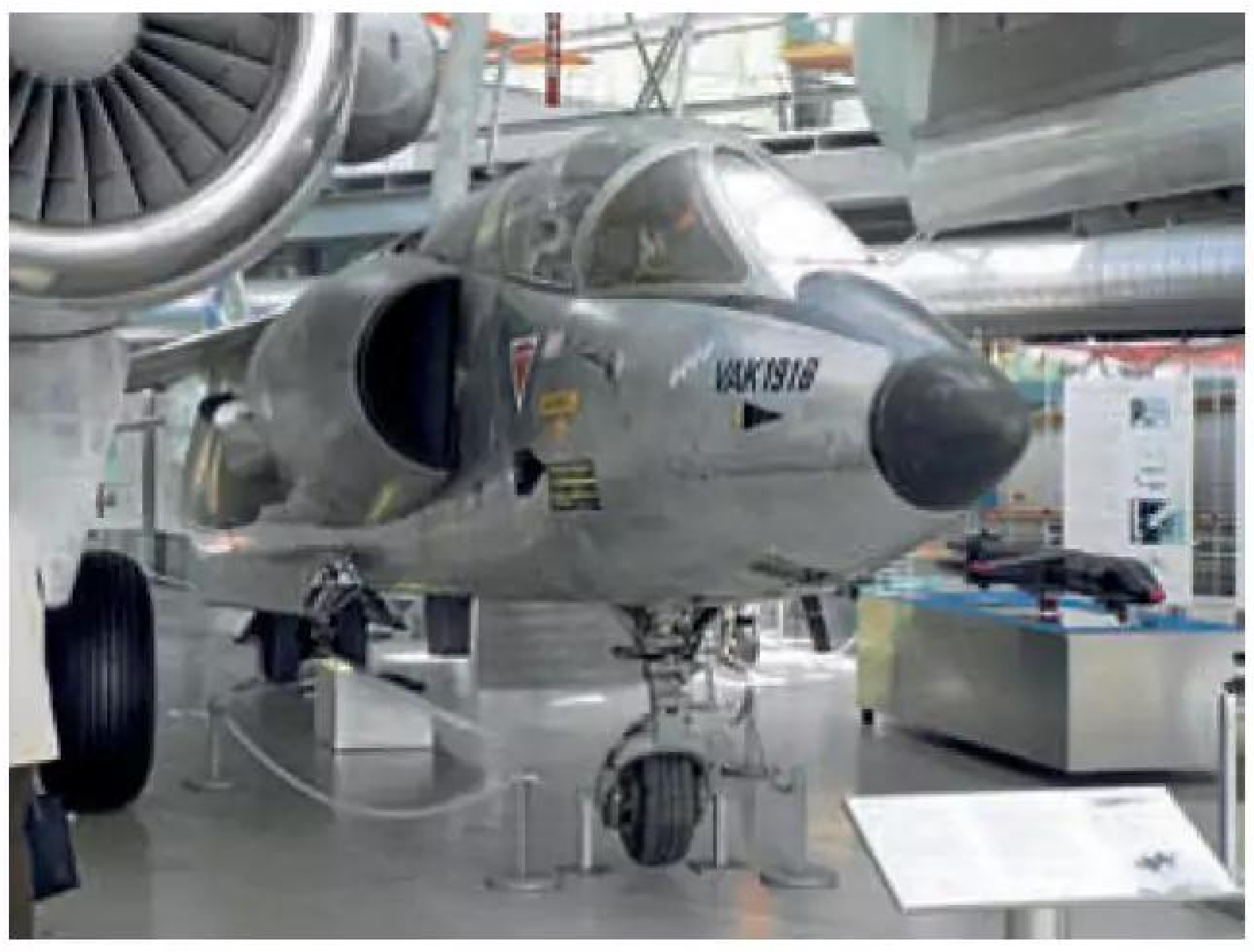
The transport aircraft competition specified in NATO BMR-4 had a number of proposals entered for consideration, but only one of these was built. The Dornier Do 31 remains the only vertical take-off jet transport ever built, and set a number of records during its short three-year flight programme.

The design was based around a straight wing with two underwing nacelles, each containing a Rolls-Royce Pegasus BE.53/2 thrust vectoring turbofan of 15,500lb (7030kg) thrust. Two wingtip nacelles each contained four Rolls-Royce RB.162-4D vertical lift engines, producing 4400lb (1996kg) of thrust each. It was intended that these additional lift engines would be optional on production aircraft when more powerful thrust vectoring main engines became available.

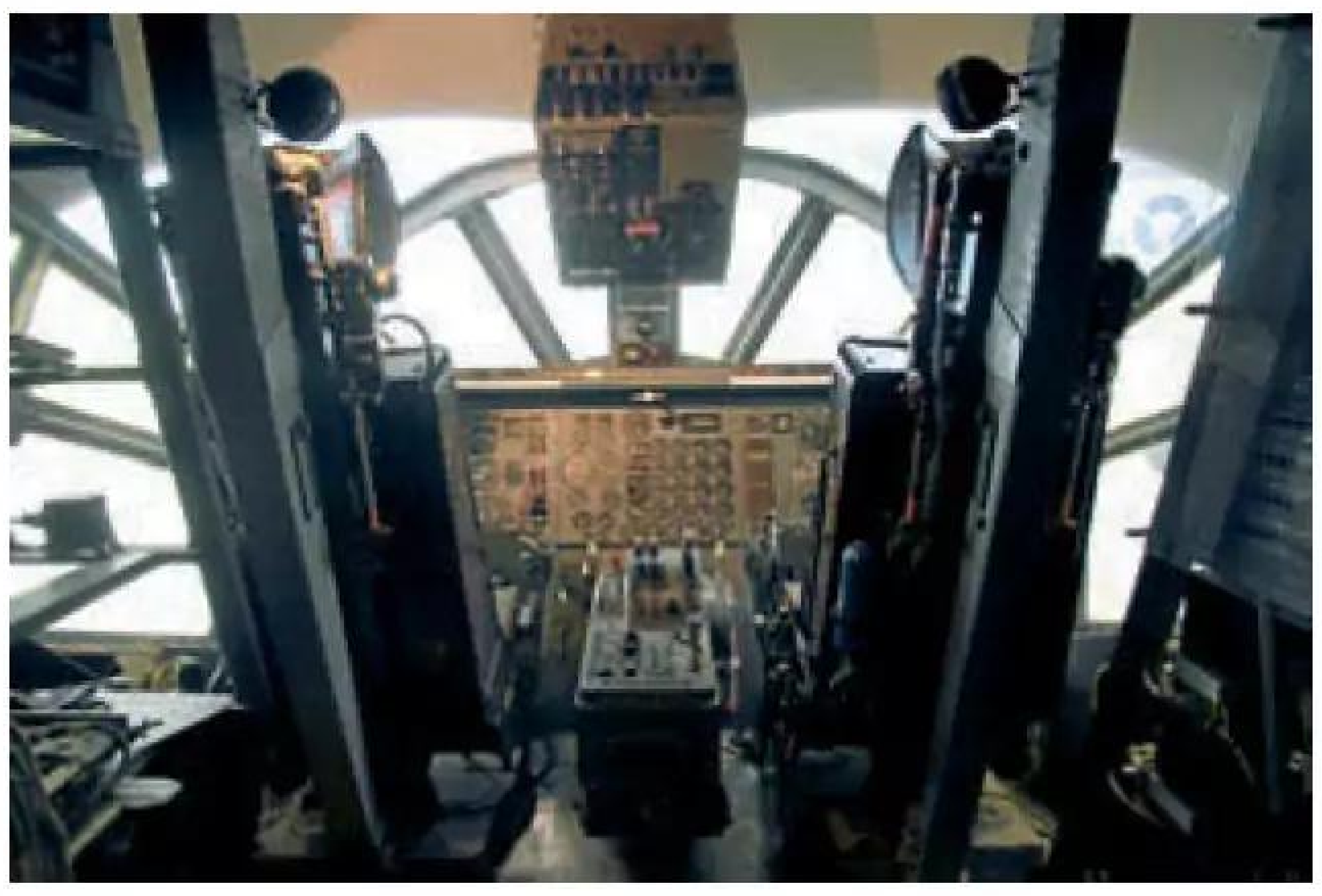
Basically, the first aircraft was the equivalent of two Harriers strapped together. The wing-mounted engines meant the fuselage was completely free for cargo and was fitted with a rear ramp door to enable vehicles or pallets to be quickly loaded.

Three aircraft were built, the E-1, -2 and -3. The E-1 had only the Pegasus engines fitted and was used to test the aircraft in horizontal flight, making its first flight on February 10, 1967. The E-2 was a static testbed and never flew. The E-3 was fitted with all 10 engines and made its first flight on July 16, 1967, making its first vertical flight on November 22 and its first successful transitions from vertical to horizontal flight in December the same year.

Due to the cancellation of the NATO BMRs, increasing costs and technical problems, the Do 31 programme ended in April 1970, but the E-3 did make one more public appearance at the world's oldest airshow, the ILA in Hanover, on May 4 that year. The E-1 is on display at the Dornier Museum in Friedrichshafen and the E-3 is on display at the Deutsches Museum Flugwerft Schleissheim.



The VFW VAK 191 B on display in the Deutsches Museum Flugwerft Schleissheim. **JP**


The cockpit of the Dornier Do 31 E-3. **Alexander Z**

There were a number of other vertical take-off and landing aircraft programmes, including those of the Yakovlev design bureau in Russia, but these were the projects that were actually built and flown. These programmes contributed a great deal of knowledge and practical experience of the problems of vertical flight to industry, and several had an effect on what was to become the world's only truly successful single engined vertical take-off and landing jet aircraft, the remarkable Harrier. ■

Words: Norm De Witt and Tim Callaway

In the beginning...

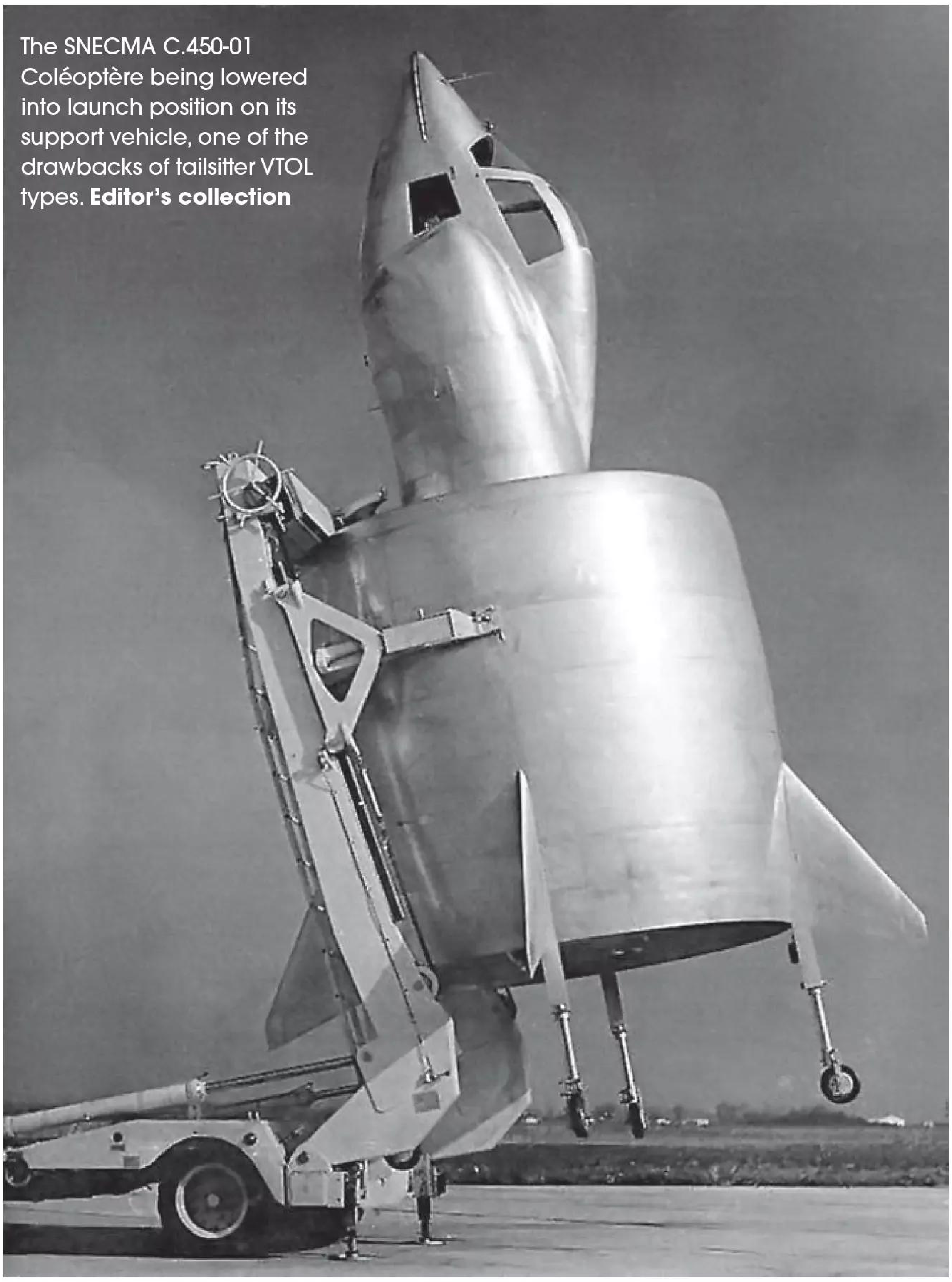
The Hawker P.1127

The techniques for vertical take-off had settled into three main areas of development during the late 1950s when a French engineer, Michel Wibault, approached Bristol Aero Engines with a different solution to the problem of providing translational thrust in two axis.

As military interest in vertical take-off jet aircraft increased through the 1950s, the techniques being explored had fallen into three main types of propulsion. The first was that of 'tailsitters', relatively conventional aircraft that had sufficiently powerful engines to launch them straight off the ground, either from sitting on a tailplane mounted undercarriage or from a ramp or similar launch platform.

These aircraft were typified by the Bachem Ba 349 Natter and Focke-Wulf Triebflügeljäger wartime concepts developed in Germany during the Second World War. Postwar, Convair, Lockheed and Ryan in the US had produced the XFY-1, XFV-1 and X-13 Vertijet, only the latter being jet propelled, the first two aircraft having powerful turboprop engines.

The French also developed the C.450-01 Coléoptère, which had an unusual annular wing. Accelerating from take-off, these aircraft translated from engine to wing-borne flight as the speed increased and the wings became effective. Slowing and stopping came from increasing the pitch of the aircraft and adding power until the aircraft was again vertical under engine power alone. Gently decreasing the power gave you a controlled descent to landing. As you can imagine, the techniques called for a great deal of pilot skill and ability. Taking off and landing lying on your back is not a natural or easy position to fly in.


The SNECMA C.450-01 Coléoptère being lowered into launch position on its support vehicle, one of the drawbacks of tailsitter VTOL types. **Editor's collection**

The second type of propulsion being investigated was that of dual engine systems, one set of engines providing direct lift for vertical flight, the second providing the thrust for horizontal wing borne flight. There were many of these programmes, from the subsonic testbed aircraft such as the Short SC.1 to the supersonic fighter prototypes such as the Mirage III-V and EWR VJ 101C in France and Germany.

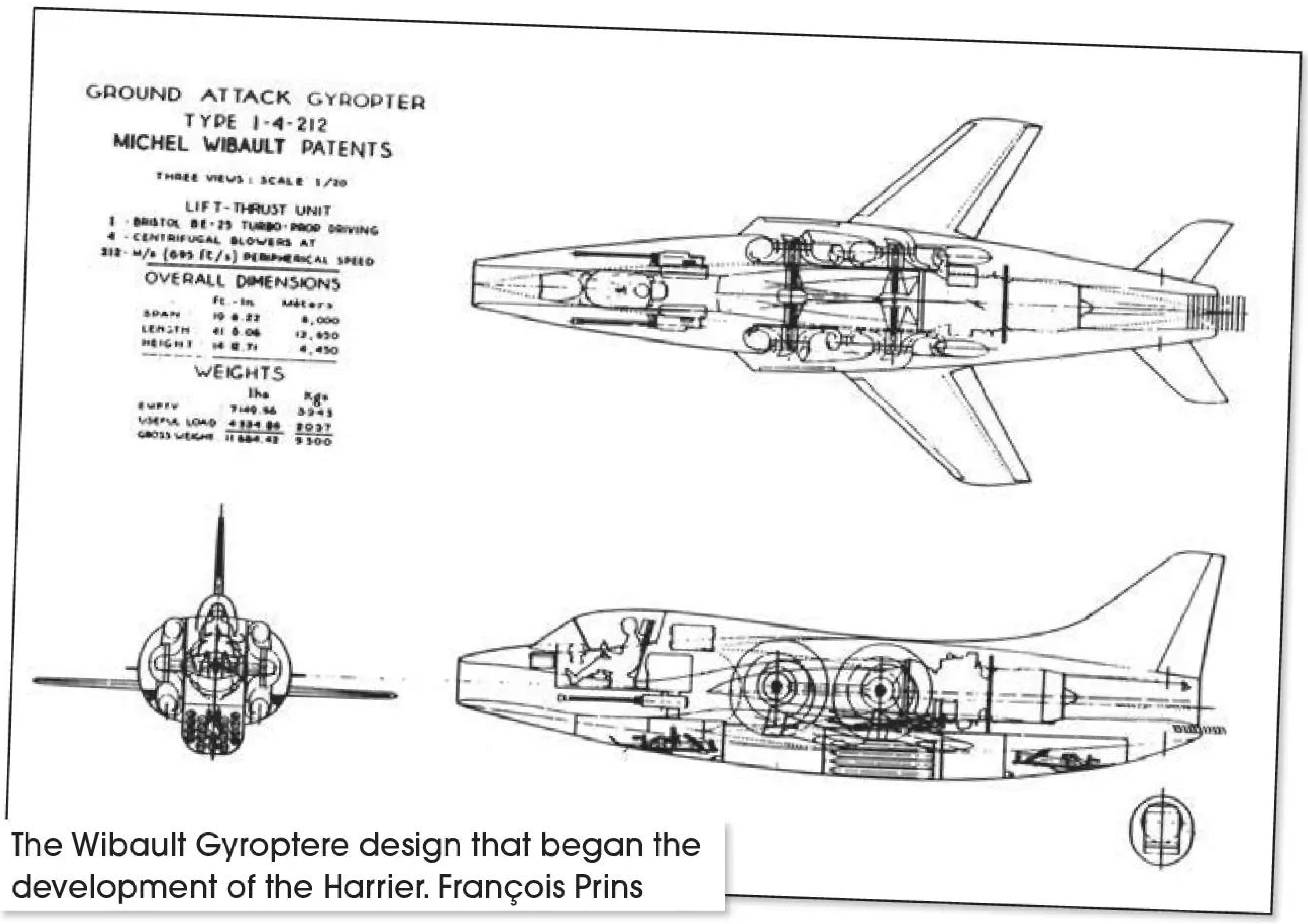
There were two major problems with these aircraft. The first was the careful balancing of forces and advanced control systems required to successfully translate from vertical to horizontal flight, which were at the cutting edge of the technology of the time, the failure of which caused a number of fatal crashes in different programmes. The second problem was that of weight. In either flight mode, the engine not in use was excess weight, which had to be propelled by the other engine system.

Fitting these two propulsion systems into the airframe also meant there was less room for fuel, weapons or other systems in the aircraft. Simply put, these designs were very inefficient and had limited range and payload carrying ability.

Lastly, conventional aircraft were fitted with oversized rocket assisted take-off boosters. These were intended to give the aircraft a very short take-off, or in the case of the German experiments with the F-104, provide enough thrust to launch the aircraft like a missile, with no take-off run at all. The boosters were jettisoned after take-off, meaning that the aircraft was unencumbered and was immediately capable of its full performance.

However, these aircraft also had a drawback in as much as they required a conventional runway for landing. Since the development of the vertical take-off aircraft was aimed at removing the one fixed

Michel Wibault in the rear cockpit of one of his 1920s designs. **Editor's collection**


GROUND ATTACK GYROPTER
TYPE 1-4-212
MICHEL WIBAULT PATENTS
THREE VIEWS : SCALE 1/20
LIFT-THRUST UNIT
1 - BRISTOL BE-25 TURBO-PROP DRIVING
4 - CENTRIFUGAL BLOWERS AT
212 - M/s (695 ft/s) PERIPHERICAL SPEED
OVERALL DIMENSIONS
ft.-in. Meters
SPAN 19 8.22 6,000
LENGTH 41 6.06 12,650
HEIGHT 14 8.71 4,450
WEIGHTS
lbs Kgs
EMPTY 7149.56 3243
USEFUL LOAD 4534.86 2057
GROSS WEIGHT 11684.42 5300

The Wibault Gyroptere design that began the development of the Harrier. François Prins

vulnerability of combat aircraft to enemy attack – their airfields – this was hardly an ideal solution.

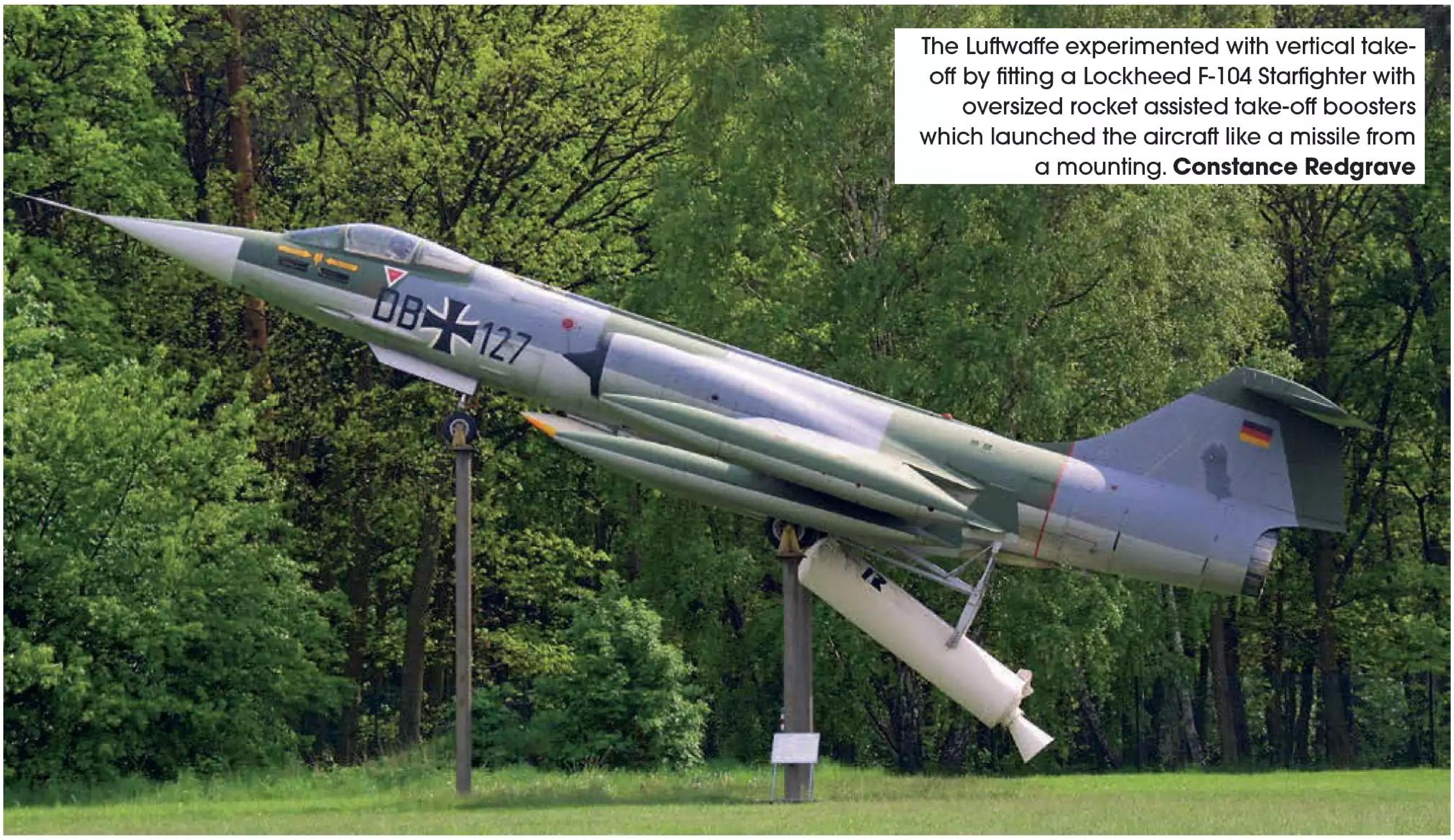
By the mid-1950s, a huge amount of time and money was being spent on solving these vertical take-off problems, when a French engineer called Michel Wibault made approaches to firstly the French then the US Governments with a very different concept.

Wibault had had a very unusual career in aviation. He had founded his own aircraft design company, SA Wibault, in France after the First World War, designing metal skinned fighters and transport aircraft. He became a consultant engineer to the British firm Vickers in 1922, producing a metal-skinned biplane fighter known as the Vickers Wibault.

With the beginning of the Second World War, Wibault emigrated to the US and found work with Alexander Kartveli, the chief designer of Republic Aviation and a former employee of SA Wibault in the 1920s. In 1953, he filed a US patent for a circular, disk shaped aircraft with an enclosed rotor called the Gyropter, which suggests he was involved in at least one Republic Aviation project of a similar type at the latter stages of the Second World War. In essence, the flying disk had a lifting rotor and thrust fans driven from a single engine to provide vertical takeoff and horizontal flight capability in a single-engined design.

By 1956, Wibault's unconventional thinking had led him to design a new single-engined VTOL strike aircraft called the Gyroptere. It was not the first vectored thrust design by any means, but it did provide the two thrust elements required for a VTOL aircraft from a single engine. It was designed to lift off horizontally, as Wibault had witnessed the difficulties experienced with 'tailsitter' type aircraft, and was fitted with four centrifugal blower units, two on either side of the fuselage, which ejected their thrust through nozzles. These four nozzles could be rotated through just over 90 degrees, providing vertical lifting thrust which could be translated to horizontal thrust as the nozzles rotated.

The engine chosen by Wibault for the design was the 8000hp Bristol Orion turboshaft, driving the blower units through gearboxes. The exhaust from this engine exited trough the rear of the aircraft's ➤



The Luftwaffe experimented with vertical take-off by fitting a Lockheed F-104 Starfighter with oversized rocket assisted take-off boosters which launched the aircraft like a missile from a mounting. **Constance Redgrave**

Sir Stanley Hooker, the technical director of Bristol Aero Engines. **Rolls-Royce**

The two men behind the success of the Harrier, Gordon Lewis and Ralph Hooper, with a copy of Wibault's brochure for the Gyroptere. **via H. Mirow**

Sir Sydney Camm, chief designer at Hawker and architect of the Harrier's development. **Editor's collection**

The Mirage III-V 001 in the Musee de l' Air at Le Bourget, Paris, was typical of the VTOL types fitted with separate lift and thrust engines, being oversized and overweight. **Constance Redgrave**

fuselage in a louvered grill, the vanes of which could direct the exhaust vertically or horizontally adding to the overall thrust of the blowers.

The idea was rejected in both France and the US, so in March 1956 Wibault approached Colonel John Driscoll of the NATO Mutual Weapons Development Program (MWDP) office based in Paris. Col Driscoll immediately saw the design had merit and consulted Theodore von Karman of the California Institute of Technology, who at the time was chairman of the NATO Advisory Group for Aeronautical Research and Development (AGARD).

Karman's reaction was equally favourable, so Driscoll passed the information on to Bristol Aero Engines in Britain. Sir Stanley Hooker, the technical director at Bristol, liked the idea of using a single engine to produce both vertical and horizontal thrust, but thought the blowers to be an inefficient way of achieving this. He set up an engineering team to study the concept, made up of Gordon Lewis, Pierre Young and Neville Quinn. Their report concluded that instead of the gearbox driven blowers, the jet engine exhaust itself could be directed through swivelling exhaust nozzles to do the same job but with far less weight and complexity.

At this point, work began on the first Bristol engine to feature vectored thrust exhausts, the BE.48, and Sir Stanley Hooker hired Michel Wibault as a consultant on the project. Wibault was delighted with the enthusiasm and inventiveness of the Bristol team and worked with them refining the concept through three different designs ending with the BE.52.

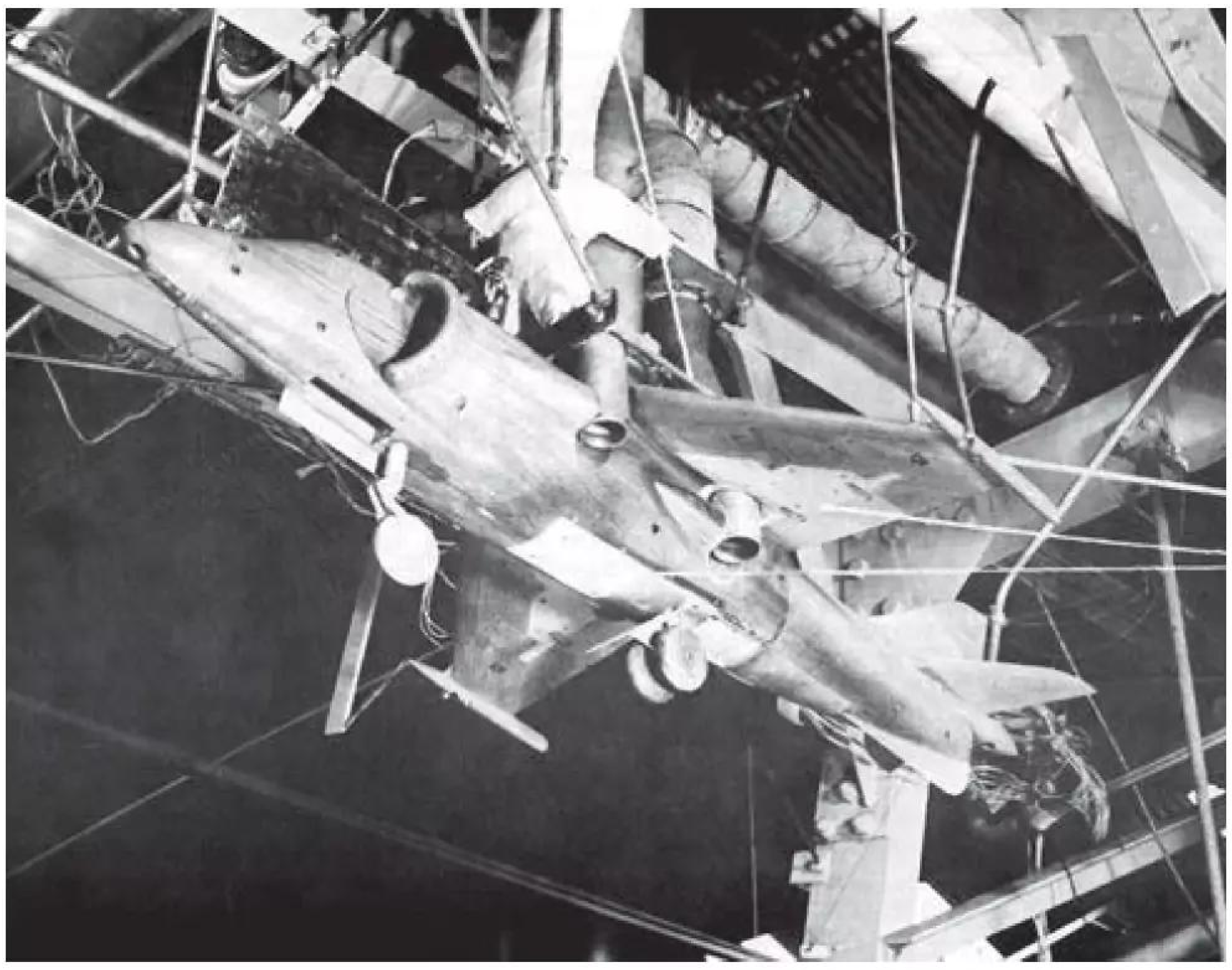
Gordon Lewis used elements of two existing Bristol engines, the Olympus and the Orpheus, in this design to produce a powerful and lightweight solution. The BE.52 had two rotating nozzles for vectored thrust from the forward fan of the engine and a single exhaust for the jet engine. This was patented as a new type of engine in the names of Michel Wibault and Gordon Lewis in January 1957, a fine tribute to two great aviation pioneers. Sadly, Wibault died a few weeks after the patent was approved and never saw the product of his genius fly.

Sir Stanley Hooker took the new engine, now called the BE.53, back to Paris, where Driscoll and Karman were very enthusiastic about its potential. Driscoll was replaced by Colonel Willis Chapman at this time, who also found the BE.53 to be an exciting prospect. By the middle of 1958, the MWDP agreed to fund 75% of the development costs, with Bristol funding the remaining 25%. The only question now was what type of aircraft could so radical a powerplant be fitted too?

An initial approach to Shorts of Belfast ended in failure as the Northern Ireland company was committed to producing the SC.1 and its separate lift and thrust engine concept. Then, in April 1957, the Minister of Defence, Duncan Sandys, announced that manned fighter and bomber development for the British military was to be cancelled in favour of guided missiles. Some projects were to be continued to maintain a manned aircraft defence while the new missile systems were developed; but it was a body blow to many thriving British aircraft companies and one of the most flawed, damaging and misguided pieces of Government interference in the aviation industry to that date.

Below: Bill Bedford flies one of the early tethered hovering tests at Dunsfold. **François Prins**

An early Pegasus engine now in the San Diego Air & Space Museum collection. **Norm DeWitt**


One of the aerodynamic models in the wind tunnel at RAE Farnborough. **François Prins**

In the light of this officially sanctioned lunacy, aircraft manufacturers were casting about for new projects to replace cancelled ones or to keep their factories open when their current aircraft came to the end of their production runs. One of these companies was Hawker Aircraft limited of Kingston, Surrey.

Hawker initially learned of the BE.53 from two sources. It had acquired copies of the Bristol brochure about the engine from the Paris Air Show of 1957, and at about the same time Sir Sydney Camm, the chief designer at Hawker, had written to Sir Stanley Hooker asking what plans Bristol had for the development of VTOL engines.

At this point one of the great innovators of the aircraft that was to become the Harrier enters the story, Ralph Hooper. Hooper was a designer working in the Hawker Projects Office and received one of the Bristol brochures. His initial design was for a threeseat light reconnaissance aircraft based around the limitations of the BE.53 engine which only vectored 50% of the available thrust. He refined this design into a two-seat aircraft with large air intakes on the sides of the fuselage, instead of the single under fuselage intake he had originally envisaged, and the project became known as the 'High Speed Helicopter' and was given the company designation of P.1127.

Hooper was dissatisfied with this concept, when he had what he later referred to as "a blinding flash of the obvious". He asked Gordon Lewis at Bristol why the jet exhaust could not be split and directed through a second pair of vectoring nozzles. He also asked that the fan section and the engine core rotate in opposite directions, to counteract the torque of the jet engine on the aircraft in hovering flight.

Bristol knew there would be problems, particularly with the latter suggestion, as it meant that they would not be able to use the fan section from the Olympus engine and would have to design a new one, but agreed to work closely with Hawker on the modifications.

The aircraft was redesigned into a singleseat ground-attack aircraft around the new four nozzle engine, and in this form the design was shown to Colonel Chapman of the MWDP at the Farnborough Air Show in September 1957, who liked the concept but said that it would require greater range capability to be a useful aircraft. To solve this, Bristol added water injection to the engine design which would produce an extra 2000lb (907kg) of thrust and effectively double the amount of fuel that could be carried internally.

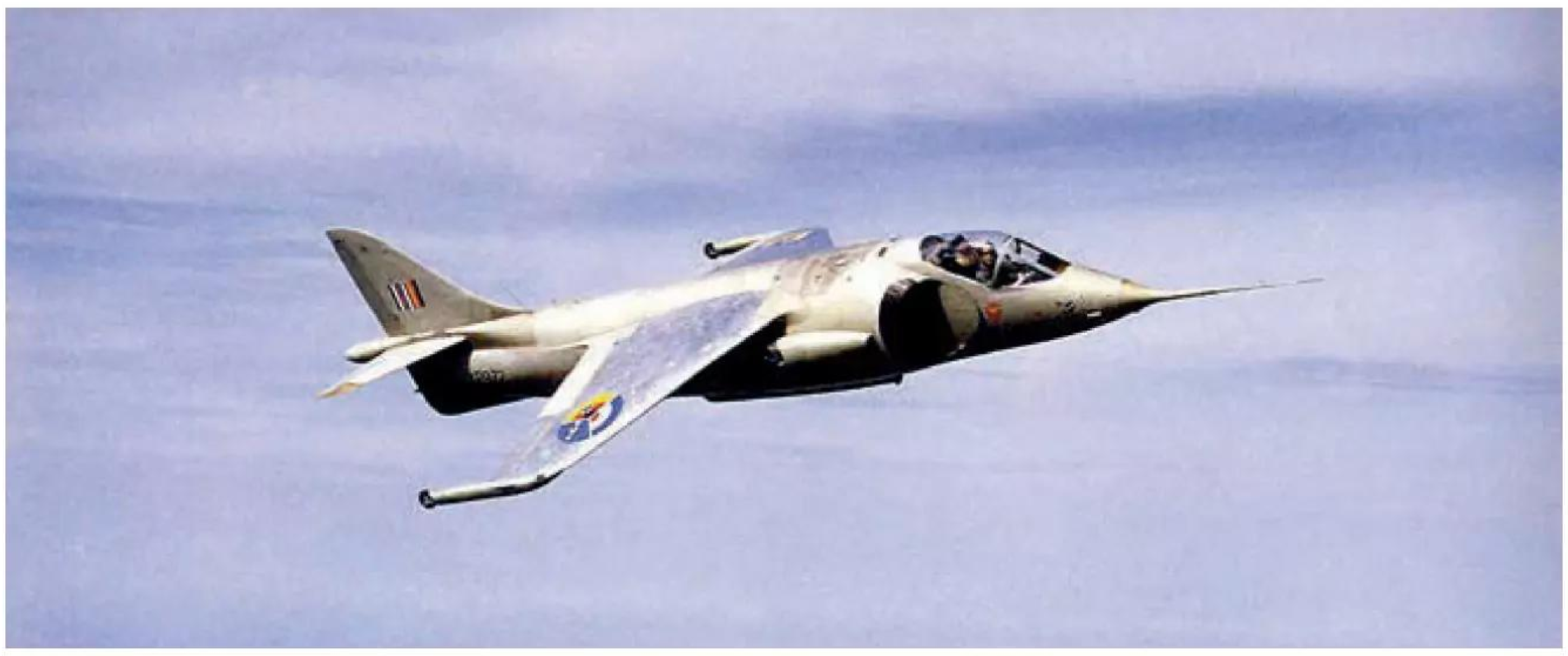
By March 1958, Bristol had solved all the problems with the engine design, simplified and lightened the exhaust nozzles and produced a new two-stage fan that eliminated the torque problem and boosted the engine power still further.

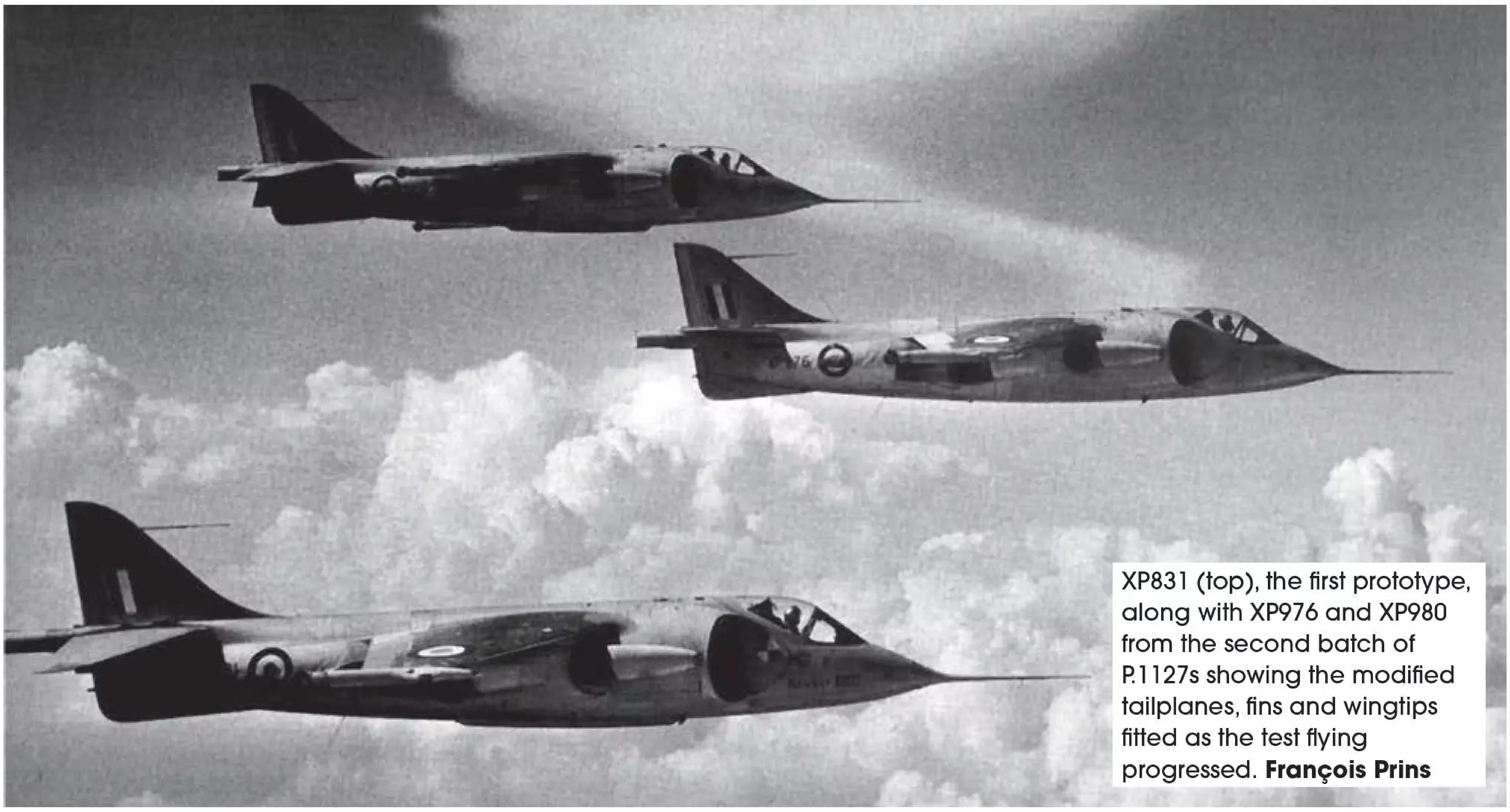
Ralph Hooper set about refining the design of the P.1127 to accommodate the new engine, now called the BE.53/2. The new engine enabled Hooper to reduce the frontal area of the aircraft and to save a great deal of weight by mounting it upside down and moving all the ancillary equipment the engine required forward of the wing. The improved engine performance reduced the amount of fuel that needed to be carried to achieve the necessary range, and the final refinement was the lightweight and now familiar tandem undercarriage with wingtip outrigger wheels for stability. The concept now looked remarkably like a Harrier.

Strangely, the undercarriage was the one part of the aircraft that Sir Sydney Camm objected to, so a number of other concepts were designed before it was decided that the tandem/outrigger layout was the only way forward on this aircraft.

The new aircraft was presented to the MWDP in March 1958 and was warmly received, with additional funding forthcoming for the engine programme. Wind tunnel testing of models began in May and detail design work began to define the P.1127's wing in August The entire project received a much needed boost when, in March 1959, the British Government sent Hawkers a copy of a new General Operational Requirement (GOR), number 345, which expressed the need for a VTOL ground-attack aircraft for RAF service by 1965. This was followed in May by an official specification for the P.1127 prototypes called ER 204D.

With this official interest in place, design and development work at Hawker and Bristol went into overdrive. A new version of the BE.53, the BE.53/3, was designed using the more powerful core of the Orpheus 6 engine as opposed to the earlier Orpheus 3. This enabled high pressure bleed air from the engine to be fed to the reaction control system at the nose, tail and wingtips, the so called 'puffer' jets that allow the aircraft to be controlled in vertical flight. The engine ➤


A rare colour photograph of XP972, the first of the second batch of P.1127s, lost on a test flight in November 1962. The aircraft is wearing the tripartite markings of the UK, US and Germany, who would jointly fly the Kestrel as a trial aircraft. **François Prins**



XP831 (top), the first prototype, along with XP976 and XP980 from the second batch of P.1127s showing the modified tailplanes, fins and wingtips fitted as the test flying progressed. **François Prins**

was also given a new name, the BE.53/2 becoming the Pegasus 1, the Be.53/3 becoming the Pegasus 2.

In late 1959, Bob Marsh, the head of the Hawker Project Office, and Ralph Hooper visited NASA at Langley Field in Virginia to study the Bell X-14 vectored thrust research aircraft and the results of its flight test programme. Here, John Stack, a NASA engineer and supporter of the P.1127, began free flight trials with model P.1127s to study the transition from vertical to horizontal flight, and later that year built a transonic model of the P.1127 powered by hydrogen peroxide.

These models were tested by NASA in January 1960 and showed the transitions to be smooth and controllable. Hawker test pilots Bill Bedford and Hugh Merewether flew the X-14 at NASA's Ames facility in March 1960, then also flew the Short SC.1 on their return to the UK to help prepare them for their P.1127 test flight programme.

On June 22, 1960, an official contract from the Ministry of Aviation was received to cover the prototypes. The first, P.1127, XP831, was moved from the Kingston factory to the Hawker airfield at Dunsfold on July 15, 1960, where the first Pegasus 2 engine was fitted in September. The stage was set for something truly remarkable – the world's first single-engined vertical take-off and landing jet aircraft was about to fly.

Throughout July, August and September 1960, engine trials, system trials and control trials were carried out at Dunsfold. With all these satisfactorily completed, on October 21, Bill Bedford flew the first tethered hover trials of the new aircraft. These were successful, although a little hairy as the tethers caused their own problems, but on November 19 the tethers came off and the first free hovering flights were made.

More test equipment was fitted to XP831 and it was taken to the Royal Aircraft Establishment (RAE) airfield at Bedford, where conventional flights were carried out from the runway there, beginning on March 13, 1961.

The second prototype, XP836, joined the test programme on July 7 and began conventional flights to expand the flight test envelope. XP836 was flown up to speeds of 538 knots (996kmh), Mach 1.03 and up to 40,000 feet (12,192m), as well as down to as little as 95 knots (176kmh) to get ready for the next test stage, transitional flight from vertical to horizontal and back again.

The first P.1127, XP831, had an uprated engine fitted, now producing 12,000lb (5443kg) of thrust in order to carry out these transitional flights. Steadily, the speed was built up from the hover to reach 95 knots so the whole speed range had been demonstrated. Then, on September 12, 1961, the big day arrived and Bedford flew the first transitional flight, finding it remarkably straightforward. Merewether followed suit and again found no problems.

Short take-offs using partially vectored thrust to allow greater payloads to be carried were also successfully demonstrated, the first taking place at Dunsfold on October 28. In just one year of test flying, the P.1127 had proved that it was able to perform exactly as promised in every way. The unconventional concept was a stunning success.

With the flight test programme under way and proving so successful, four more P.1127s were ordered by the Ministry of Aviation in November 1960 and incorporated a number of design changes and improvements suggested by the test flight results. On December 14, 1961, Bedford had ejected from XP836 when one of the glass fibre engine nozzles had detached, so all subsequent nozzles were made of steel.

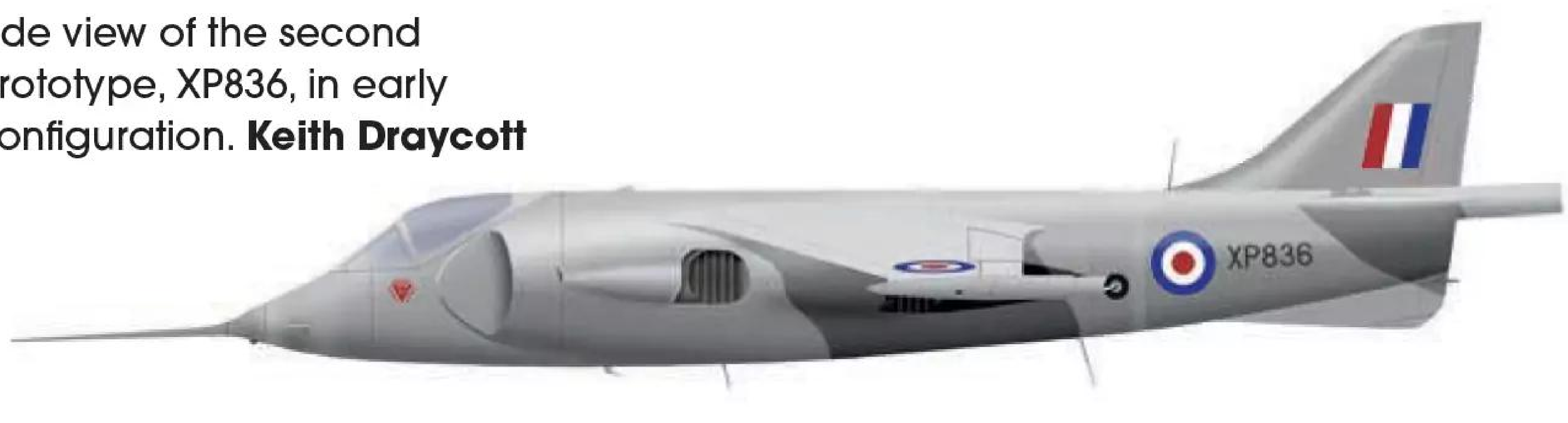
XP972, 976 and 980 started test flying between April 1962 and February 1963, but XP972 was destroyed on October 30, 1962, when the engine failed and Merewether made a dead-stick landing at RAF Tangmere.

Various other modifications were introduced on the fleet as testing continued. The fins were enlarged, the tailplanes were given the now familiar anhedral angle and the wingtips were streamlined, all to counter undesirable flight characteristics encountered in the trials.

More powerful Pegasus 3 engines were fitted which improved the performance of the prototypes markedly, particularly in the hover and transition as they produced 13,500lb (6124kg) of thrust. The last P.1127, XP894, had all of these modifications when it first flew in February 1964 and also included a new wing design with a swept trailing edge, a longer fuselage and a bigger Pegasus 5 engine delivering 15,000lb (6804kg) of thrust. In this form, XP984 was to become the prototype for the next step in the Harrier's evolution, the Kestrel. ■

Words: Tim Callaway

Side view of the second prototype, XP836, in early configuration. **Keith Draycott**



The Kestrel, P.1154 & the first Harriers

Several reasons why it's best not to mix politics and aviation

With the success of the P.1127 prototypes in flight test, multinational interest was shown in the programme which spurred the development of the first operational versions of a VTOL aircraft.

With the development of the new Pegasus 5 engine delivering 15,000lb (6,804kg) of thrust came increased British Government interest in the P.1127 as it was now clear that an aircraft equipped with this engine could fulfil the RAF's needs for a VTOL ground-attack aircraft as specified in GOR.345, a requirement issued in March 1959. By 1960, European interest was also piqued, as there were a number of NATO requirements being formulated for VTOL aircraft and several research programs going on in France and west Germany. The NATO funding for the Pegasus engine project led to the P.1127 being considered for the NATO Basic Military Requirement (BMR) 3. However, it was quickly realised that the performance of the P.1127 would not meet the initial specification for the NATO VTOL programme.

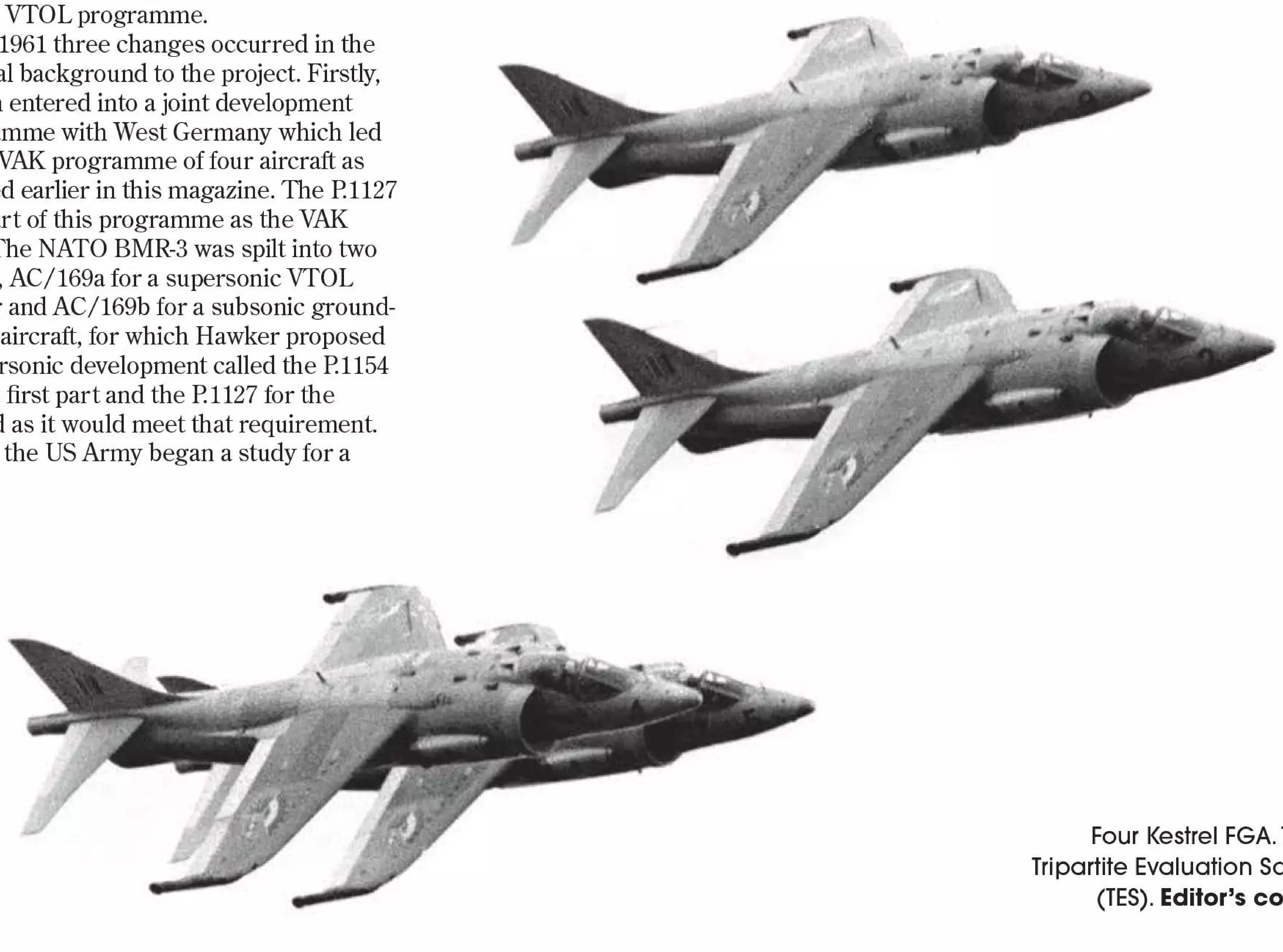
In 1961 three changes occurred in the political background to the project. Firstly, Britain entered into a joint development programme with West Germany which led to the VAK programme of four aircraft as detailed earlier in this magazine. The P.1127 was part of this programme as the VAK 191A The NATO BMR-3 was spilt into two halves, AC/169a for a supersonic VTOL fighter and AC/169b for a subsonic ground-attack aircraft, for which Hawker proposed a supersonic development called the P.1154 for the first part and the P.1127 for the second as it would meet that requirement. Lastly, the US Army began a study for a close support aircraft which included the P.1127 and had the potential to require up to 1000 aircraft. The future of the programme looked rosy, when two decisions were made that changed the situation completely.

POLITICAL CHANGES

The original maximum speed of the aircraft specified in GOR.345 had been 0.95 Mach. This was suddenly raised to 1.2 Mach, beyond the reach of the P.1127. The RAF began to lose interest in the aircraft as a potential Hunter replacement. This was followed by the German decision to concentrate on the Fw.1262 design to meet the VAK requirement. Suddenly, the NATO BMR was the only potential customer left for the aircraft.

In light of the potential US interest, the Ministry of Aviation (MoA) took a hand in order to keep the programme alive. In May 1962 a US Army delegation visited Kingston to discuss the P.1127 and the potential to build the aircraft in the US with Northrop being the chosen partner. Given these encouraging signs, the MoA began negotiating a deal for a tripartite development of the P.1127 between Britain, West Germany and the US.

The RAF's interest was lukewarm to say the least. The German interest was only ever as a technical evaluation of the concept in operation; they were firmly committed to the VAK 191B by this time. At the same time, the US Air Force objected to the US Army acquiring its own fixed wing ➤



Four Kestrel FGA.1s of the Tripartite Evaluation Squadron (TES). **Editor's collection**

2
U.S. AIR FORCE
418262

Hawker Siddeley XV-6A, 418262, now in the US Air Force Museum at Wright Patterson AFB. **US Air Force**

Hawker Siddeley Kestrel FGA.1, XS691, touching down at West Raynham in Norfolk, the home base of the TES. **Editor's collection**

aircraft, which fuelled the controversy over the programme on both sides of the Atlantic. However, on January 16, 1963, after a negotiation process that was as confusing as it was protracted, Britain, Germany and the US agreed to jointly fund the cost of producing nine new developed aircraft to equip a tripartite evaluation squadron. The new aircraft was initially referred to as the P.1127, but in the light of the many changes to the airframe, it was later named the Kestrel FGA Mk.1.

With the flight test programme ongoing at Dunsfold, Hawker decided that the new aircraft would incorporate all of the modifications that had been applied to XP894, the last P.1127 built, with the new swept wing and longer fuselage, enlarged fin, drooped tailplane and Pegasus 5 engine.

The nose probe of the P.1127 trials aircraft was removed and a single reconnaissance camera mounted facing forward to enable operational trials to take place in the reconnaissance role. The airframe was fully stressed for combat trails and pylons could be mounted on the inboard hard points on the wings to carry fuel tanks or weapons. To facilitate weapons trials, the Kestrels also had a simple tracking sight fitted. Interestingly, the production aircraft had the facility to carry the additional outer pylons and be fitted with a Doppler navigation and auto-stabilisation system, but due to the financial limitations of the trial agreement, this equipment was never fitted. This additional equipment had been intended for the RAF version of the P.1127 and had already been factored into the design when service interest in the type declined.

THE KESTREL

The first Hawker Siddeley (as the company was then called) Kestrel flew on March 7, 1964, and production continued steadily until the last was delivered in March 1965. The test pilots chosen to fly the trials were drawn from the Luftwaffe, the RAF and all three US services, the Army, Navy and Air Force. These pilots started training at Dunsfold during October 1964, until the Tripartite Evaluation Squadron (IBS) was officially formed on April 1, 1965, at RAF West Raynham in Norfolk. Flying on the TES must have been not only taxing and interesting but also tremendous fun.

The trails were aimed at evaluating not just the aircraft, but also to develop procedures on how to operate V/STOL fighter bombers in the field. To this end, short take off and vertical landing routines for sorties were developed, known as STOVL, which were seen as being the most efficient way to operate the aircraft. Off-airfield operations were practised, including developing concealment and dispersal methods and equipment. Rough strip take offs and landings were practiced at RAF Bircham Newton, where everything from soft and boggy ground to a variety of temporary surfaces such as pierced steel planking were used to evaluate the Kestrel's ability to operate on any kind of terrain. Attack missions were simulated by the aircraft, but the TES never carried any actual weapons, concentrating instead on developing the techniques of using a V/STOL aircraft effectively.

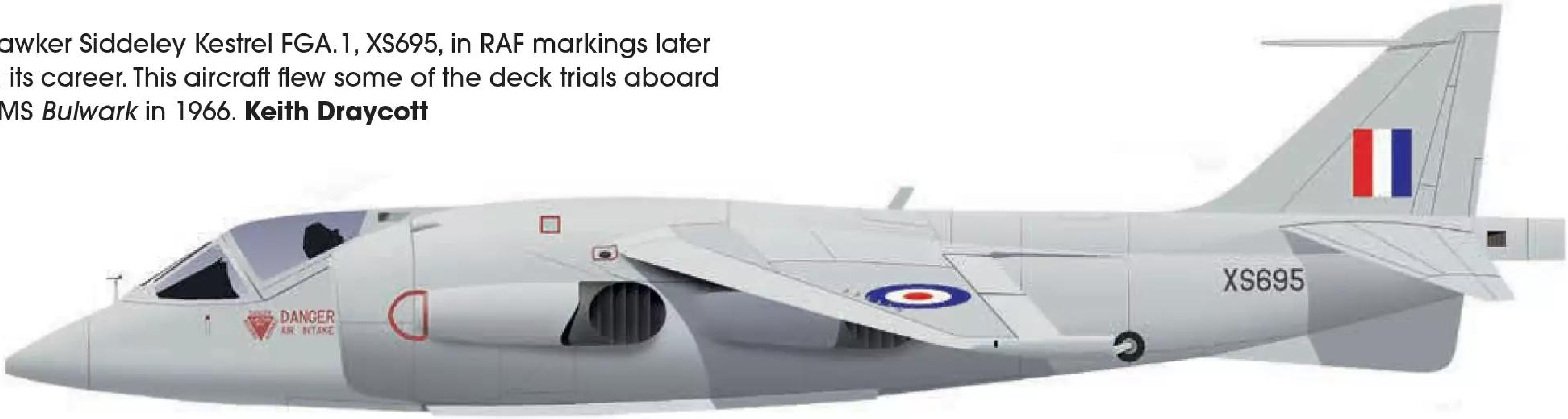
A number of very important lessons were learned about the operation vertical take-off and landing aircraft, not least of which was the effect of the jet exhaust in two major respects. Firstly, some of the exhaust's hot gases could be re-ingested by the engine under certain circumstances in the hover, and cause a marked loss of power at a critical stage in flight. Secondly, the exhaust from the engine could cause ground erosion at dispersed sites, leaving tell-tale marks and damaging the surface the aircraft was operating from. The TES developed methods to alleviate both of these effects.

Altogether 1367 sorties were flown by the TES with only one aircraft being lost during the trials, a remarkable achievement considering the new technology under test. The trials were considered complete in November 1965 and the unit disbanded.

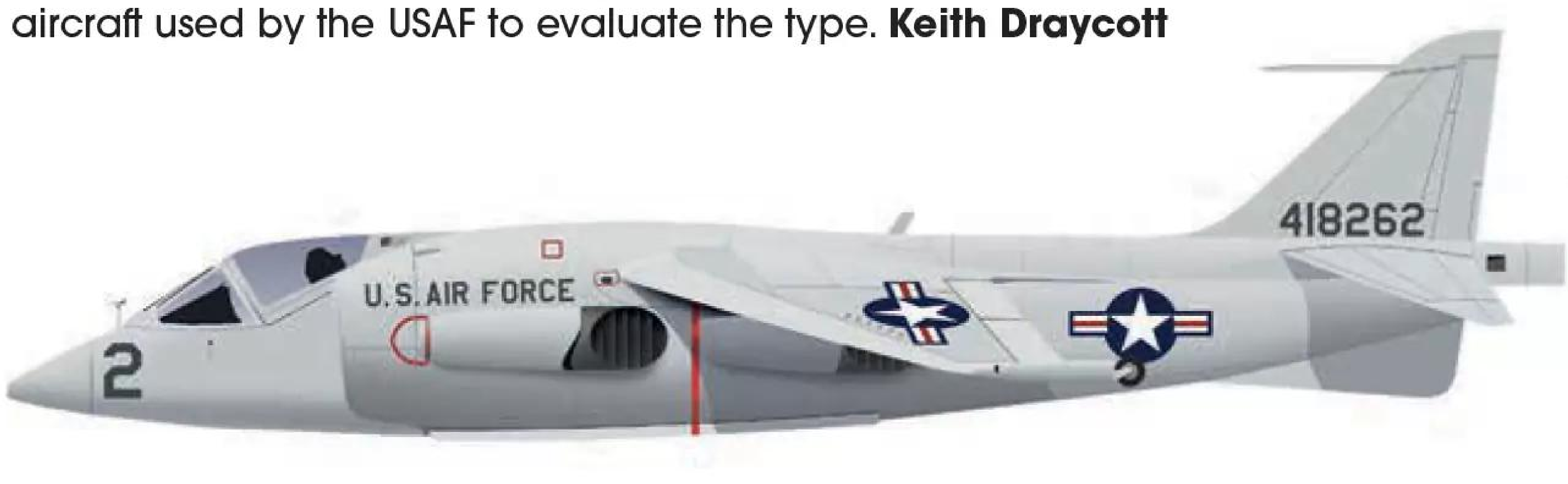
This was not the end of the Kestrel as a test aircraft however. Of the eight remaining aircraft, two stayed in the UK and took part in extensive deck trials aboard HMS *Bulwark* in 1966, proving the ability of the aircraft to operate at sea. One outcome of these deck trails was that reactive metals like magnesium would not be used on future versions of the aircraft to increase the fire safety of the type in the confined spaces of an aircraft carrier.

One of the aircraft was sent to the Blind Landing Experimental Unit at RAE Bedford, and the last, XS693, was modified at the Blackburn factory at Brough in

Hawker Siddeley Kestrel FGA.1, XS695, in RAF markings later in its career. This aircraft flew some of the deck trials aboard HMS *Bulwark* in 1966. **Keith Draycott**



Yorkshire to take the uprated Pegasus 6 engine. The remaining six aircraft were sent to the US where they were used as trials aircraft by all three services before four were transferred to the US Air Force at Edwards Air Force Base as experimental aircraft. The remaining two were acquired by NASA who conducted a wide variety of aerodynamic and experimental trials with them. Known in US service as XV-6As, several survive today in museums in the US.



Hawker Siddeley XV-6A, 418262, one of the experimental aircraft used by the USAF to evaluate the type. **Keith Draycott**

THE P.1154

Mention must be made of the P.1154 in any book on the Harrier, as it was the original aircraft to be given the name. Initially called the P.1150, the design was a response to the supersonic requirements outlined in the modified RAF GOR.345 and NATO BMR-3. Bristol Siddeley as the company was now called, had begun development of the BS.100 engine, which featured Plenum Chamber Burning (PCB) for the front nozzles, increasing the thrust considerably and making supersonic performance possible.

A change in the specifications for BMR-3 meant a larger aircraft was required and a modified design called the P.1154 was laid out by Ralph Hooper. This design was the joint winner of the BMR-3 competition, the P.1154 winning on technical merit, the Dassault Mirage III-V winning in terms of workshare and multinational development potential. The Ministry of Aviation saw the potential of the design and drew up a joint RAF and Royal Navy requirement in 1962 for a supersonic VTOL fighter to replace the Hawker Hunter with the RAF and the de Havilland Sea Vixen with the Royal Navy. Hawker Siddeley modified the P.1154 proposal to meet the requirements of both, and consequently satisfied neither, as the needs of the services were diverging with the RAF wanting a single seat ground-attack fighter and the Navy a two-seat interceptor, so interest in the project waned.

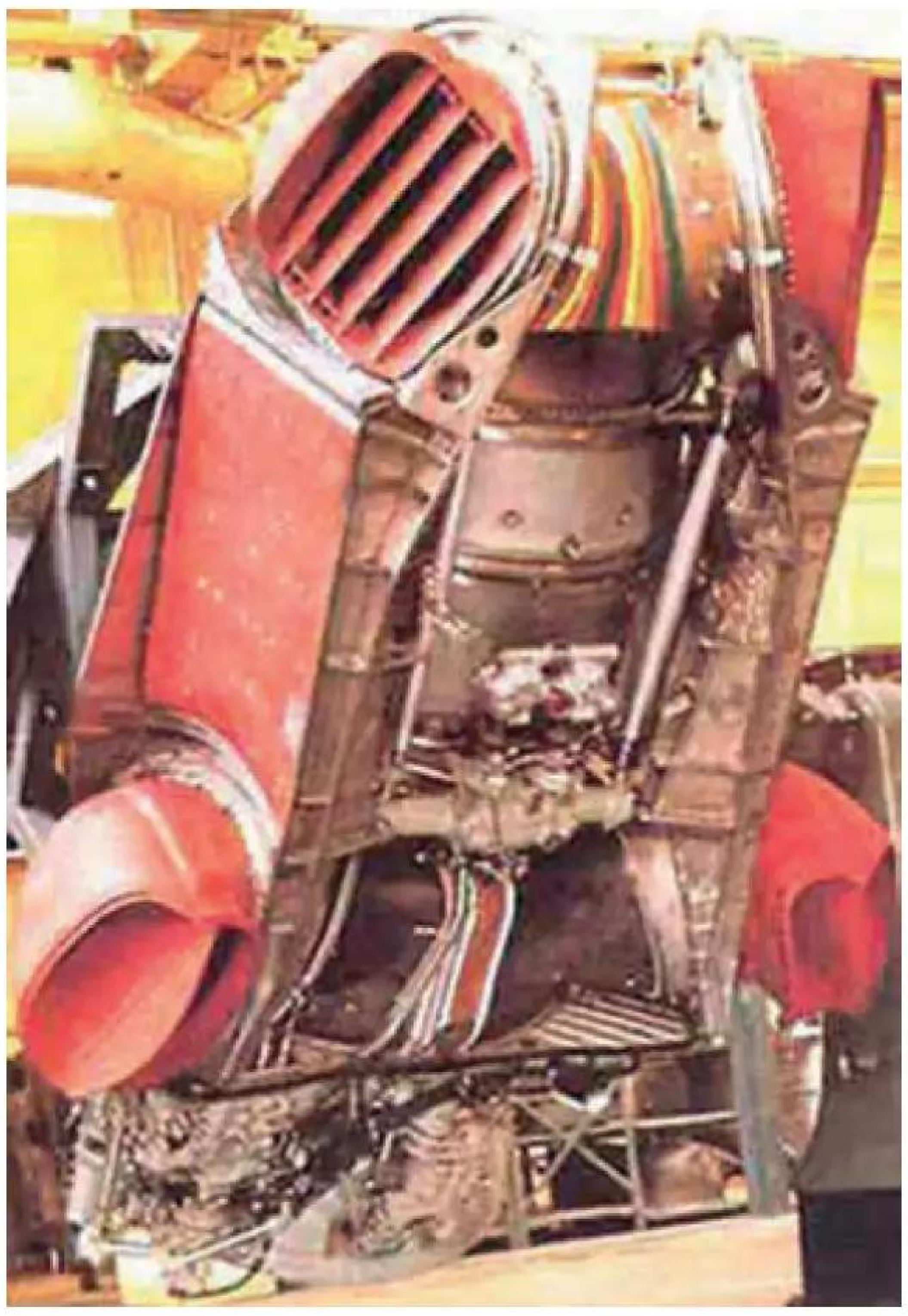
The attempt by Rolls-Royce to offer a PCB equipped twin Spey powerplant with vectored thrust muddied the waters further, but on July 16, 1963, both services agreed on a common design but with different radars. There was still disappointment over the weight and performance of the common aircraft programme, so consequently, in November 1963, the British Government announced that the Royal Navy requirement would be met by the McDonnell Douglas F-4 Phantom with Rolls-Royce Spey engines.

This was not all bad news however, as it allowed Hawker Siddeley to concentrate on the RAF version of the P.1154. On February 26, 1964, the Government announced that the P.1154 with the BS.100 engine had been ordered for the RAF as its new strike fighter. On October 30 of that year, the BS.100 engine ran for the first time, and proved successful in trials of the

➤

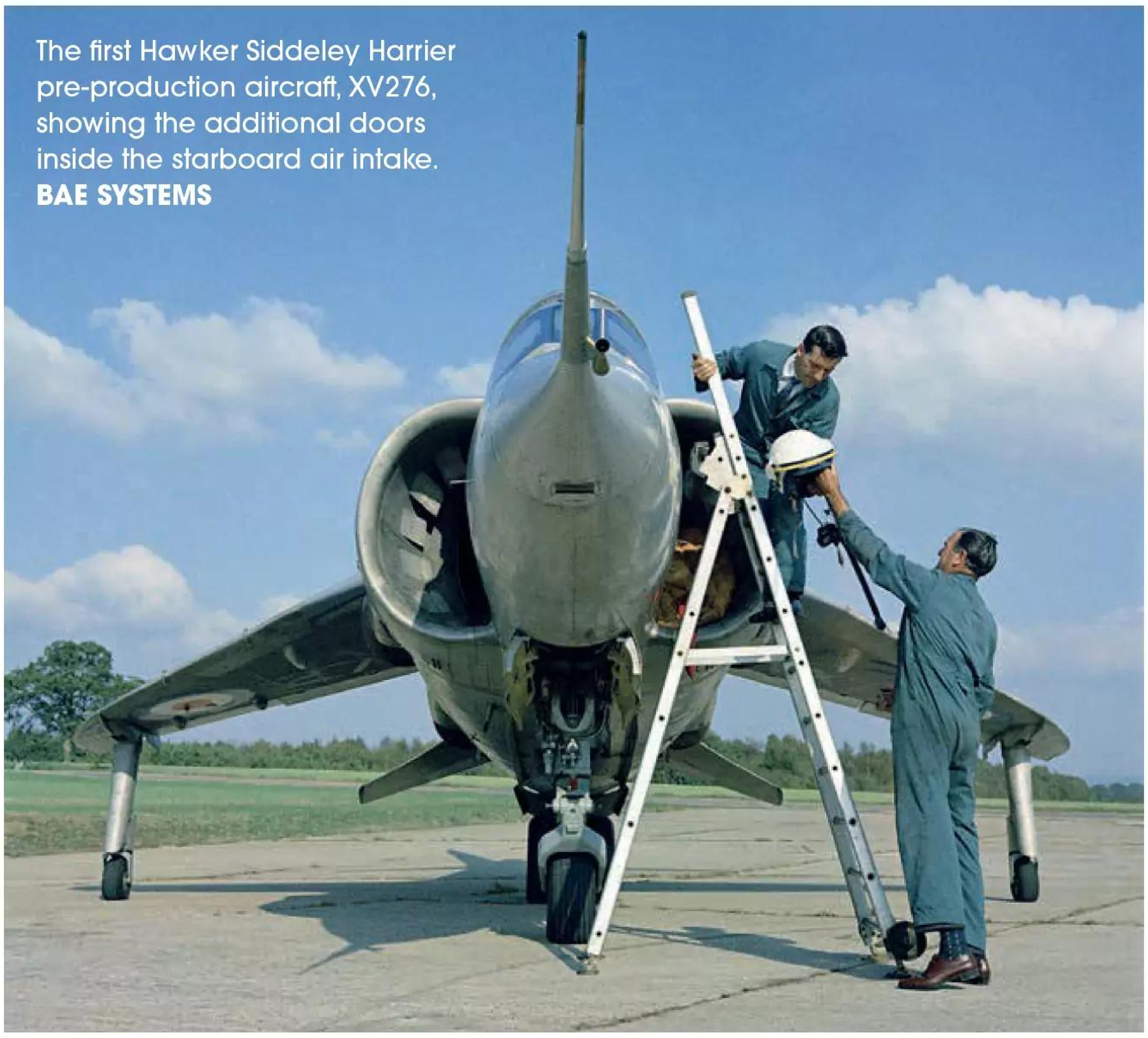
Aircraft and pilots of the Tripartite Kestrel Evaluation Squadron pictured at West Raynham, Norfolk, in September 1965. **BAE SYSTEMS**

DANGER AIR INTAKE
4
2
5
0
9
8



The Bristol Siddeley BS.100 engine with PCB for the forward nozzles, the engine intended for the P.1154. The red paint is heat resistant. **via H. Mirow**

The first pre-production Hawker Siddeley Harrier, XV276, on a test flight at Dunsfold, Surrey, in 1966. **BAE SYSTEMS**



The first Hawker Siddeley Harrier pre-production aircraft, XV276, showing the additional doors inside the starboard air intake. **BAE SYSTEMS**

PCB system. Hawker Siddeley had begun building the first batch of aircraft when suddenly, on February 2, 1965, the new British Labour Government cancelled the project on the ground of cost.

The P.1154 is, like the TSR2, one of those great 'what if' aircraft in aviation history. Given its performance, similar to the Phantom, and its development potential and likely overseas sales, it is interesting to speculate what the effect of the type on subsequent history may have been. The Falklands War, fought with a supersonic performance VTOL fighter armed with radar-guided missiles, would have been a different conflict, as would several of the other wars fought subsequent to its cancellation. However, the work and effort of two years of development was not completely wasted, the new Government decided that the RAF was to receive the Phantom, but to meet all its operational requirements it was also to receive a new ground-attack aircraft based on the P.1127, called the P.1127(RAF) and later given what had been the P.1154's name, the Harrier.

AT LAST, THE HARRIER

Coming only a few days after the cancellation of the P.1154, the initial contract from the MoA covered only a study of the development of an improved P.1127. The new aircraft was essentially a combination of the P.1127 concepts prepared for the US Army, the original GOR.345 and the Anglo-German VAK project, along with a number of aerodynamic refinements from the Kestrel and P.1154 programmes. The first major change was the use of the Pegasus 6 engine producing 19,000lb (8618kg) of thrust, which required a change to the intakes.

To make them more efficient at low speed and in the hover, six small doors were fitted around the outside of the intake that opened automatically. The wing was extended with longer curved tips to move the centre of lift backwards and improve the longitudinal stability of the aircraft. Five hard points were fitted for pylons, four under the wing and one under the fuselage for the carriage of up to 4000lb (1814kg) of external stores. Two aerodynamic fairings could be carried under the fuselage on either side of the central pylon which contained a pair of 30mm Aden cannon for ground strafing, and provision was made to carry a reconnaissance pod on the centre pylon. In April 1965, the study was accepted by the MoA, and two months later a contract was placed to build six development aircraft.

Kestrel XS693 had been modified by fitting the Pegasus 6 engine and the intake doors, as already mentioned, and provided valuable experience in testing the new engine. This led to the P.1127(RAF) being produced with eight intake doors instead of six to improve intake efficiency still further and to allow for the future developments of the Pegasus engine with greater power.

The first of the six pre-production Hawker Siddeley Harriers at Kingston in 1966. **Editor's collection**

Given all this engineering experience and expertise available from earlier stages of the programme, Bill Bedford took to the air in the first P.1127(RAF), XV276, on August 31, 1966, just 14 months from the contract being issued.

Just prior to this, in June 1966, Hawker Siddeley was contracted to undertake a 12-month study to develop a two-seat training version of the aircraft, and in early 1967, the first contact for 60 aircraft, now named Harrier GR.1 was approved. The Harrier had arrived. ■ *Words: Tim Callaway*

Into service and into the headlines

The Harrier GR.1 to GR.3

With the first 60 production aircraft of the P.1127(RAF) programme ordered and named Harrier, and the two-seat trainer under development, the aircraft began operational development to ready it for service.

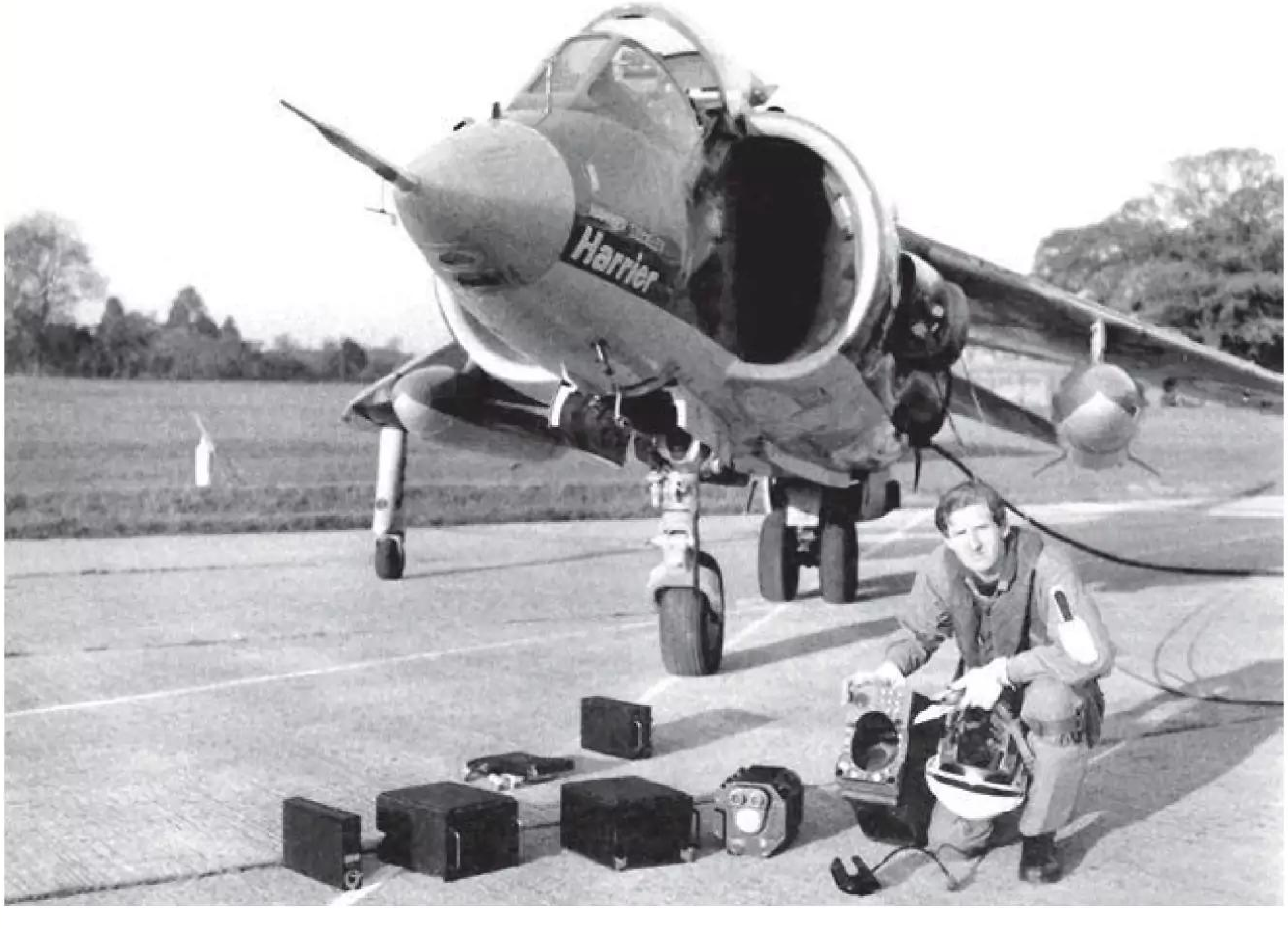
Midway through 1966, as the first production development P.1127 (RAF) was flying for the first time, Rolls-Royce bought Bristol Siddeley Aero Engines and continued the development of the Pegasus under its banner.

The developments and test flying by Hawker Siddeley up to this point had focused on proving the concept of the vectored thrust VTOL aircraft and improving its performance and handling.

With the first order secured for an operational version, flight testing and development changed emphasis to integrate weapons aiming, navigation and other equipment which would turn an experimental concept into a military aircraft.

With all six development aircraft being evaluated by service test pilots from the Aircraft and Armament Experimental Establishment (A&AEE) at Boscombe Down and Hawker Siddeley test pilots at Dunsfold, flight testing also began to focus on operational needs. This included developing methods for operating the Harrier in the field and flying weapons trials to clear the Harrier to carry a wide range of ground-attack munitions.

The entire weapons system was based around what was one of the most accurate inertial navigation systems of the period, the Ferranti FE541. This was combined with a weapons aiming computer, moving map display and Specto head-up-display, all of which served to reduce the cockpit workload – an important factor in a single seat ground-attack aircraft, particularly with the unusual handling of the Harrier.


Test pilot Duncan Simpson shows the heart of the Harrier GR.1 weapons system, the Ferranti FE541 inertial navigation system, Specto head-up-display and moving map display. **François Prins**

The trials showed that the relative simplicity of the aircraft had a number of advantages, making it both reliable and easy to maintain. These were important characteristics for an aircraft that would be operated from unprepared sites, a long way from the traditional maintenance and support facilities demanded by more conventional aircraft.

FALLOUT FROM THE SIX-DAY WAR

While this testing was going on in 1967, the Six-Day War between Israel, Iraq, Lebanon, Egypt, Jordan and Syria took place from June 5 to June 10.

During this conflict, the air forces of the countries opposing Israel were practically wiped out in a series of attacks on airfields, some 416 aircraft being destroyed for the loss of 26 Israeli fighters and bombers in the first two days alone. This underlined the importance of fielding air power that could operate from dispersed sites, away from vulnerable airfields.

Given the 1967 economic crisis in Britain, another round of cuts in military spending was demanded by the UK Treasury. However, in February 1968, in the light of the Six-Day War, it was decided to cancel the RAF order for 50 F-111Ks, the aircraft intended to replace the cancelled TSR.2 programme, instead of the Harrier.

The results of the war had another effect on the Harrier programme; as well as ensuring its political survival it also spurred interest in the aircraft from overseas, particularly from the US... of which more later.

The pace of the test and development flying was boosted by the delivery of the first five production aircraft to Dunsfold during the latter half of 1968. On January 1, 1969, the Harrier Conversion Team (HCT) was formed at RAF Wittering, but for the first three months of the year most ➤

1 Squadron Hawker Siddeley Harrier GR.1s on a field deployment exercise in March 1972. **BAE SYSTEMS**

Hawker Siddeley Harrier GR.1s of 20 Squadron, during Exercise Grim Charade held during July and August 1973. **BAE SYSTEMS**

Hawker Siddeley P.1127(RAF)s alongside the first Harrier GR.1s pictured at Dunsfold aerodrome, Surrey, in 1968. **BAE SYSTEMS**

Harrier GR.1 of 4 Squadron on a deployment exercise in June 1976, taking off from a strip in a mown wheat field. **BAE SYSTEMS**

of its pilots were undergoing a helicopter training course to learn about vertical flying, hovering and some of the effects experienced close to the ground. Then, based at Dunsfold with Hawker Siddeley, they learned to fly the Harrier. The first two seaters had not yet been produced, so at the time a pilot's first solo flight in a Harrier was also his first flight in the type!

By April 1, the HCT was in business at Wittering, training the pilots who would fly the Harrier in the first RAF Squadron to be equipped with a vertical/short take-off and landing (V/STOL) jet aircraft, No 1 Squadron.

THE FIRST HARRIER SQUADRON

Up until June 1969, 1 Squadron had been operating the Hawker Hunter in the ground-attack role at RAF West Raynham in Norfolk as part of 38 Group.

The squadron motto In Omnibus Princeps (First in All Things) had never been truer when it was declared operational on the Harrier on January 1, 1970 – becoming the first operational V/STOL unit in the world.

Under the command of Wing Commander Ken Hayr, later Air Marshal Sir Kenneth William Hayr KCB, KEE, AFC and Bar, 1 Squadron was co-located at RAF Wittering alongside the HCT.

During its conversion onto the Harrier, the squadron took part in an event that captured the public imagination and demonstrated the capabilities of the Harrier to the world.

The event was the *Daily Mail* Transatlantic Air Race in May on the 50th anniversary of the first crossing by John Alcock and Arthur Whitten Brown, the aim being to travel from between the top of the Post Office tower in London to the top of the Empire State Building in New York (or vice-versa) in the fastest possible time. Without doubt, the global press and television coverage of the event spurred interest in the Harrier and showed that the RAF now had a unique capability to the world.

One other factor that even appeased the political opponents of the aircraft as it entered service was that, uniquely for a British jet combat aircraft, the entire programme was both on cost and on time.

THE HARRIER GAINS STRENGTH

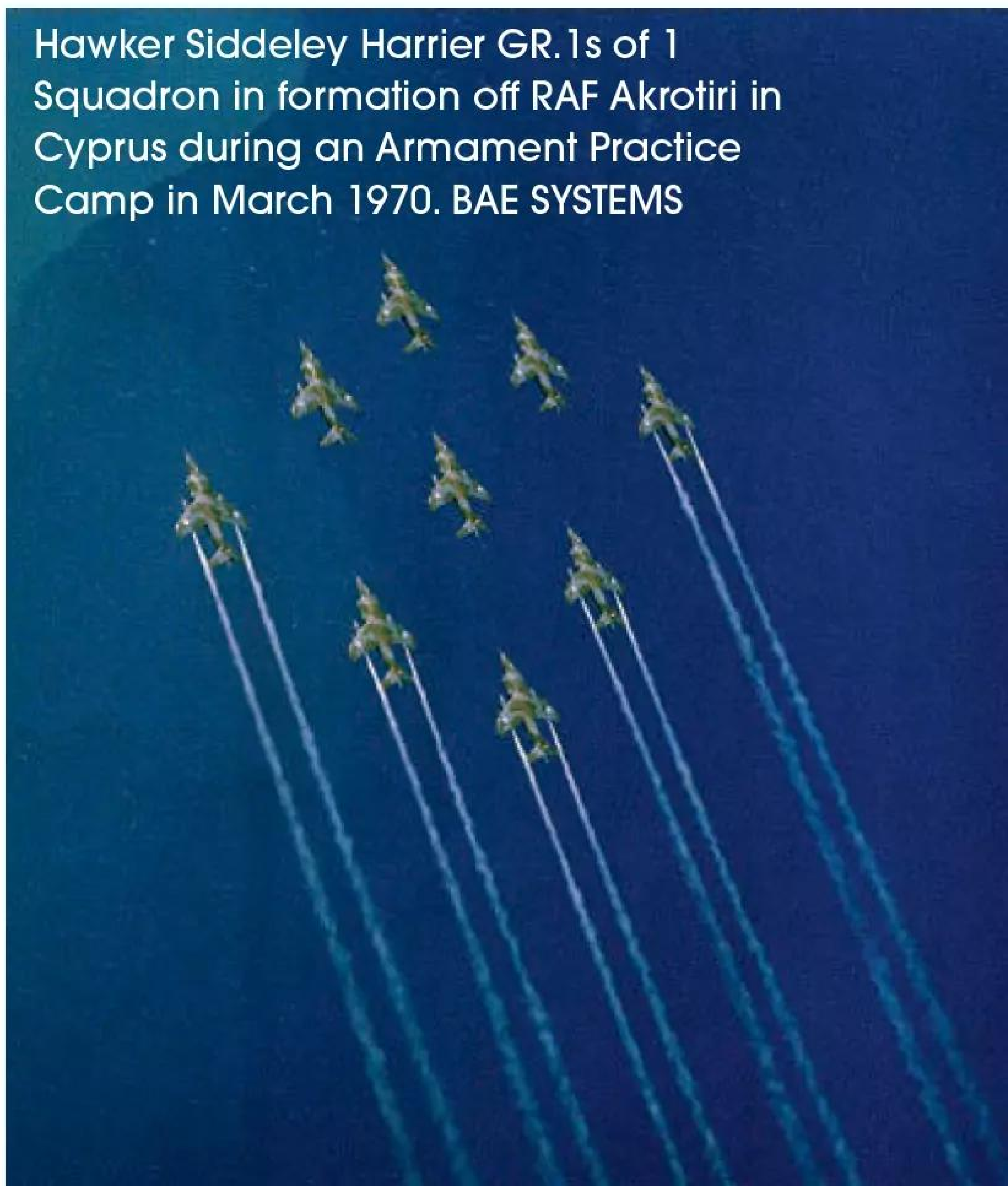
The next Harrier units to form were to serve in RAF Germany, the first of these being 4 Squadron, which, like 1 Squadron, had been operating Hunter FGA.9s in the ground-attack role.

The squadron transferred to West Raynham in September 1969 to work up on the Harrier GR.1 at RAF Wittering, before returning to RAF Wildenrath in Germany in June 1970. It was closely followed by 20 Squadron, which had been flying Hunters in Singapore before disbanding and moving to RAF Wittering in the second half of 1969. It joined 4 Squadron at RAF Wildenrath in December 1970. 20 Squadron was short lived as a front-line Harrier unit because in February 1977 it was decided to move the RAF Germany Harrier units to RAF Gutersloh, which could not accommodate three squadrons. The squadron was disbanded and its aircraft split between 4 and the last Harrier squadron to form, 3 Squadron. This was not the end of 20 Squadron's association with the Harrier, as will be discussed later.

3 Squadron had been flying Canberras at RAF Laarbruch before reforming at RAF Wildenrath on January 1, 1972, on the latest version of the Harrier, the GR.1A.

The GR.1 had been powered by the Pegasus 6, now termed the Pegasus Mk 101 under the Rolls-Royce engine numbering scheme, which produced 19,000lb (8618kg) of thrust. The next development was the Pegasus 10 Mk 102 with 20,500lb (9299kg) of thrust. This engine was fitted to 17 new-build Harriers and 41 refurbished GR.1s, designated as GR.1As. This engine was also to power the first US version of the Harrier, the AV-8A, which will be covered later.

All the other three squadrons, 1, 4 and



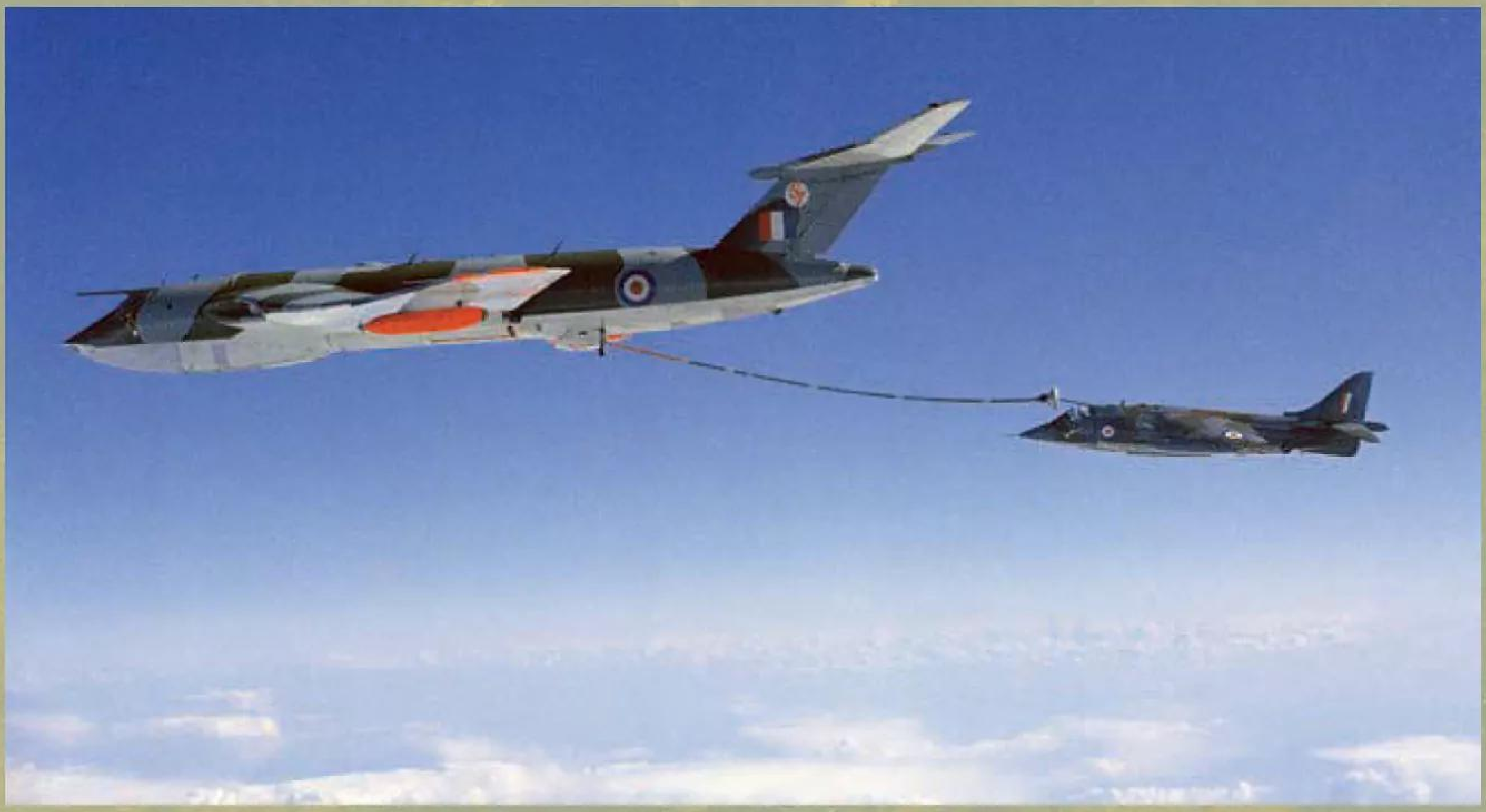
Hawker Siddeley Harrier GR.1s of 1 Squadron in formation off RAF Akrotiri in Cyprus during an Armament Practice Camp in March 1970. BAE SYSTEMS

The west to east record time of 5 hours 11 minutes and 57 seconds was set by the Royal Navy 892 Squadron crew of one of its new McDonnell Douglas F-4K Phantoms, XT858 – namely Lt Cdr Brian Davies and Capt Peter Goddard.

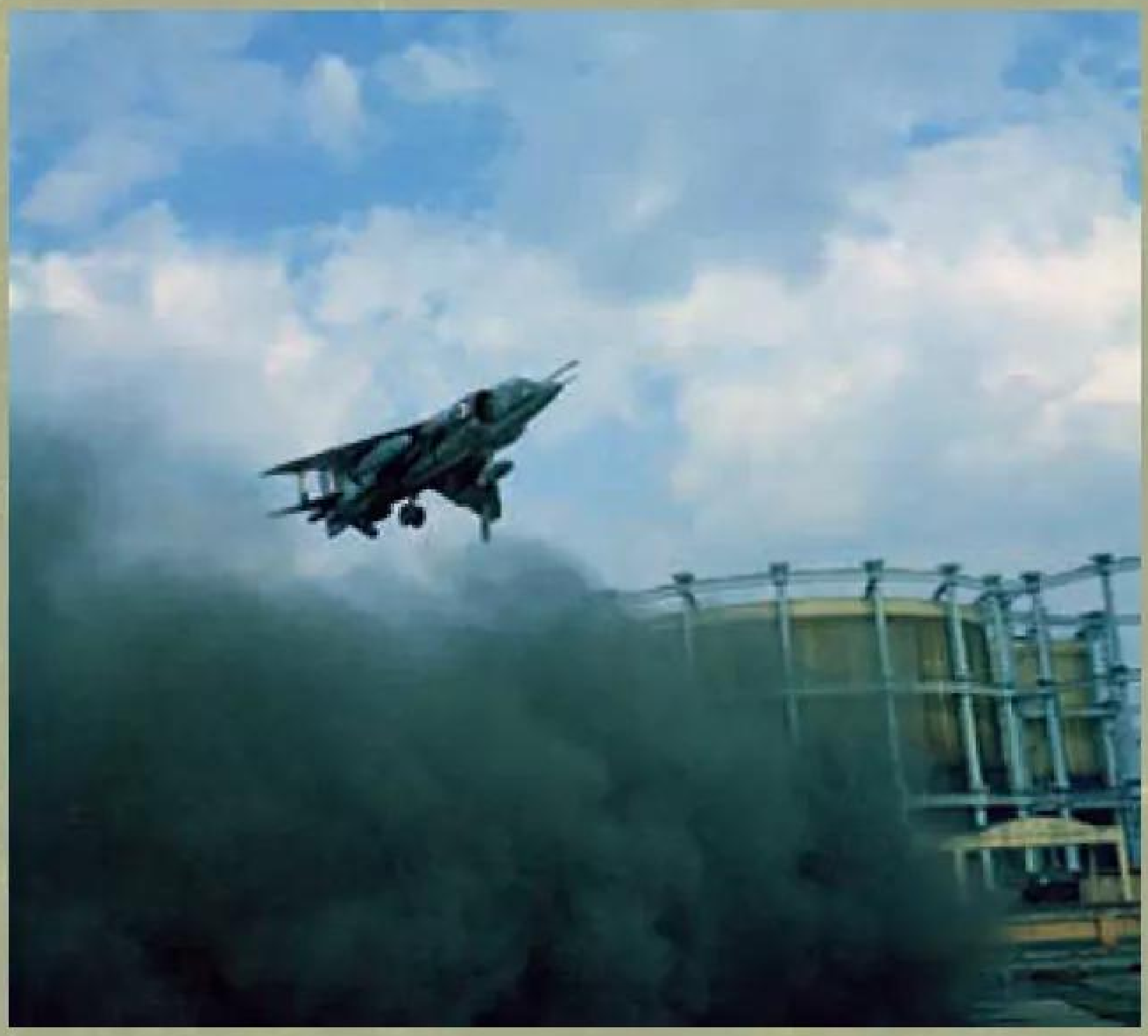
To achieve this feat, the runner – in this case Peter Goddard – 'legged it' from the top of the Empire State Building to a waiting motorcycle and was driven at speed to the 30th Street West heliport on Manhattan Island, to a helicopter that took him to Naval Air Station Floyd Bennett. Here he jumped into the back seat of the Phantom, and after several in-flight refuellings from Victor tankers, arrived at Wisley Airfield near Guildford, transferred to a waiting Wessex that flew him to a building site at the foot of the Post Office tower … which he then had to run up. Exhausting!

The RAF had a different idea for the crossing, using its new aircraft to enable its race entry flight to be almost point to point.

A coal yard near St Pancras station was discovered as a site suitable for a Harrier to operate from, and a demolished factory site belonging to a convent was found on the East River in New York. Motorcycles were arranged for the intervening short distances between these sites and the objectives, and a 1 Squadron Harrier was prepared for the event.



Hawker Siddeley Harrier GR.1, XV741, refuelling from a 57 Squadron Victor K.1A of 57 Squadron, XH618, in a series of trials ahead of the 1969 Transatlantic Air Race. **François Prins**



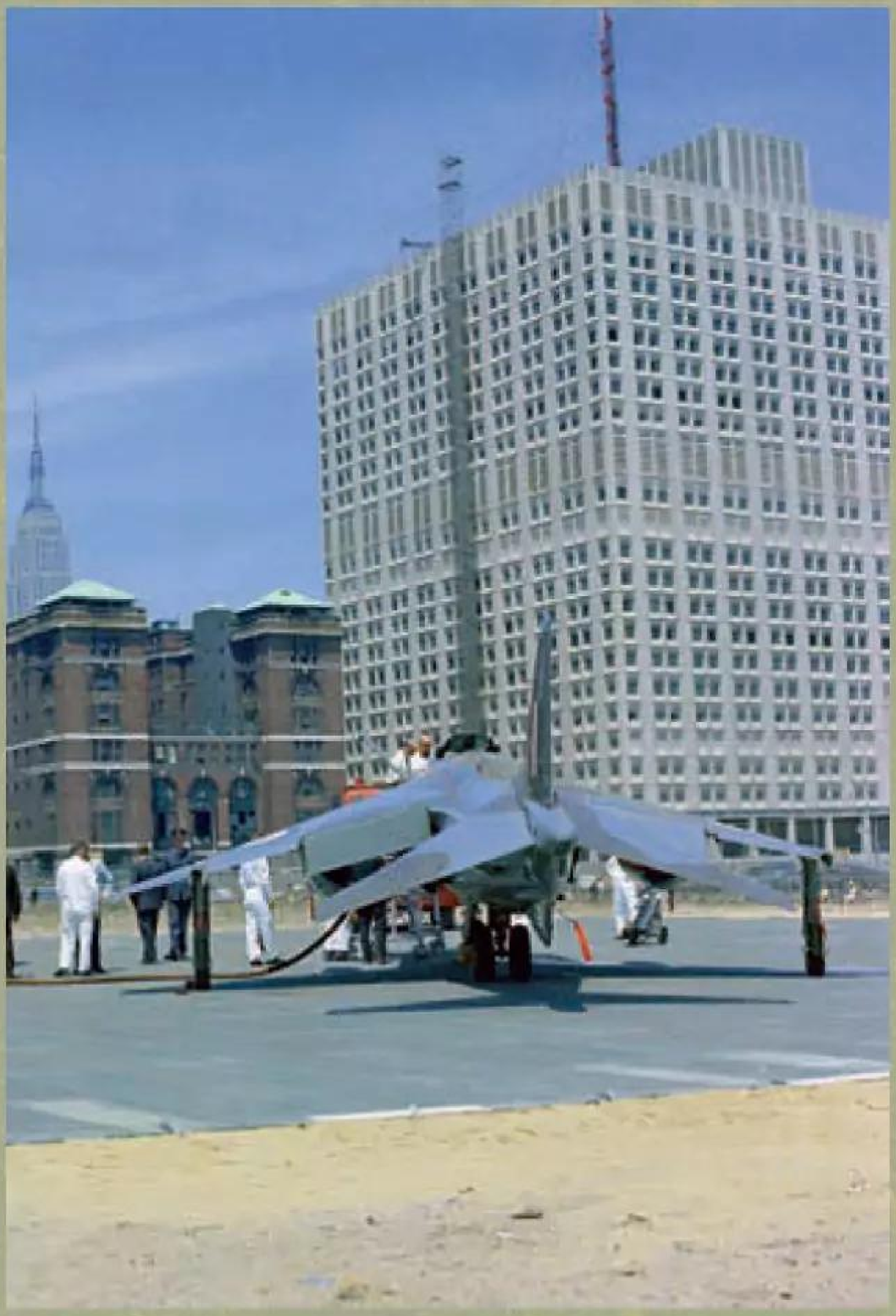
Squadron Leader Tom Lecky-Thompson brings his Hawker Siddeley Harrier GR.1, XV741, in to land at a disused coal yard adjacent to London's St Pancras station. **BAE SYSTEMS**

At the time the Harrier GR.1 could be fitted with a fixed refuelling probe for long ferry flights; a retractable probe was not to be a feature of the Harrier until the later GR.5.

On May 5, 1969, live television coverage saw Sqn Ldr Tom Lecky-Thompson fly Harrier GR.1 XV741 out of the coal yard in the middle of the city, a tremendous public relations coup for the RAF and Hawker Siddeley.

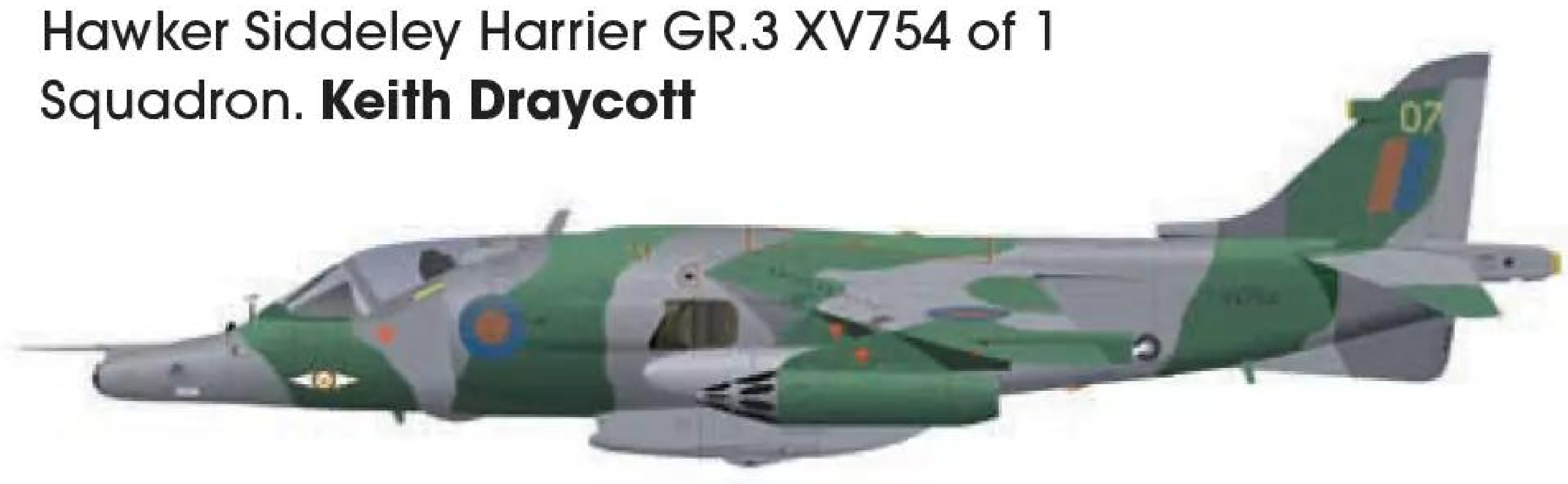
After four in-flight refuellings, he arrived in New York and jumped aboard the waiting motorcycle that took him to the Empire State Building, achieving a time of 6 hours 11 minutes and 57 seconds over the complete course.

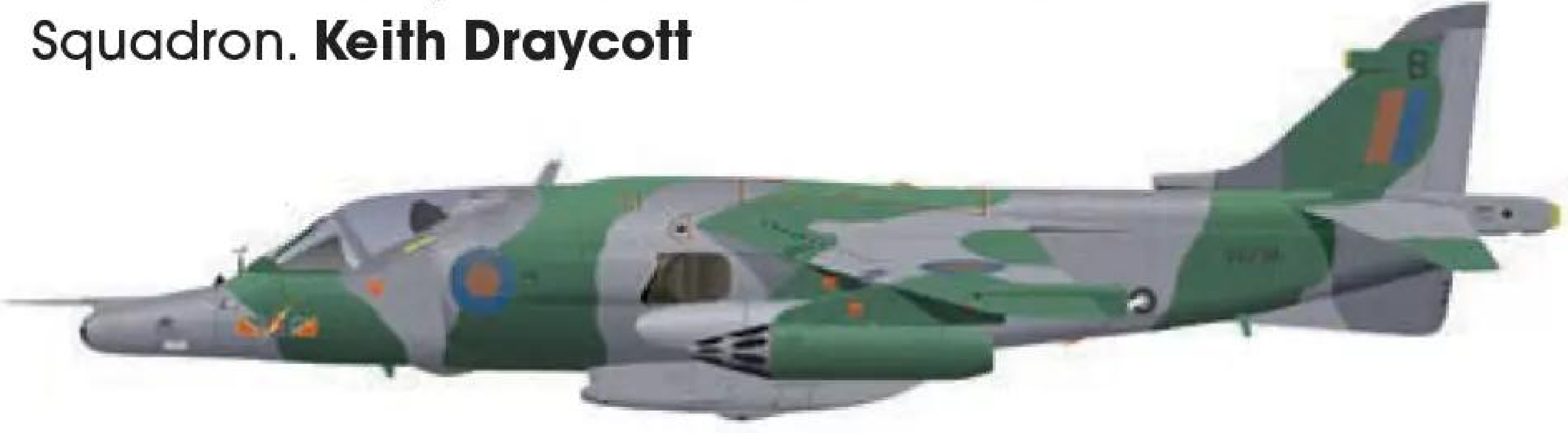
This was deemed the fastest subsonic entry into the race, winning the east to west leg. ➤



Hawker Siddeley Harrier GR.1, XV741, at the demolished factory site on the East River after completing the London to New York flight. **US Air Force**

A Hawker Siddeley Harrier GR.1 undertakes one of the early tests of the ski-jump concept. **BAE SYSTEMS**


Hawker Siddeley Harrier GR.3 XV754 of 1 Squadron. **Keith Draycott**


Hawker Siddeley Harrier GR.3 XZ134 of 3 Squadron. **Keith Draycott**

20, had received the new aircraft during 1971, the last GR.1A being produced for 3 Squadron during 1972. The increased power gave the Harrier more flexibility with regard to weapons and fuel loads, particularly at take off and on recovery to base.

On a weapons training sortie in the GR.1, any unexpended weapons had to be jettisoned prior to landing. The extra power of the new engine meant they could land safely with weapons still on the pylons.

At this time the Harrier was considered almost as a two-part force. The three RAF Germany-based squadrons were considered as close air support and reconnaissance units, the idea being that in the event of a Soviet ground-attack in Europe, the Harriers could operate against their troops, tanks and vehicles with relative impunity from dispersed hides in the German forests, even if all the airfields were destroyed in the first enemy air strikes.

Meanwhile, 1 Squadron at RAF Wittering was quite different, considered part of Britain's rapid reaction forces. In its first year of operation, 1970, 1 Squadron had deployed to Cyprus in March and Norway in September, not only confirming the rapid deployment capability of the Harrier, but also its ability to operate successfully in a wide range of climates.

The trials conducted aboard HMS *Ark Royal* in 1971 with the newly re-engined GR.1A proved that the Harrier could be deployed abroad and operate from Royal Navy ships with ease. In 1977 a new method for launching Harriers from ships, a simple curved ramp called a ski-jump, was tested at RNAS Yeovilton using a variety of A&AEE, RAE and 1 Squadron Harriers. This was successful and later adopted on all Royal Navy aircraft carriers. The ski-jump enabled Harriers to take off at far greater weights than a standard short take off, meaning they could carry more fuel and more weapons.

These trials were the beginning of a relationship between the Royal Navy and the Harrier which was to last up to the final retirement of the type in 2010.

HONING THE WEAPON

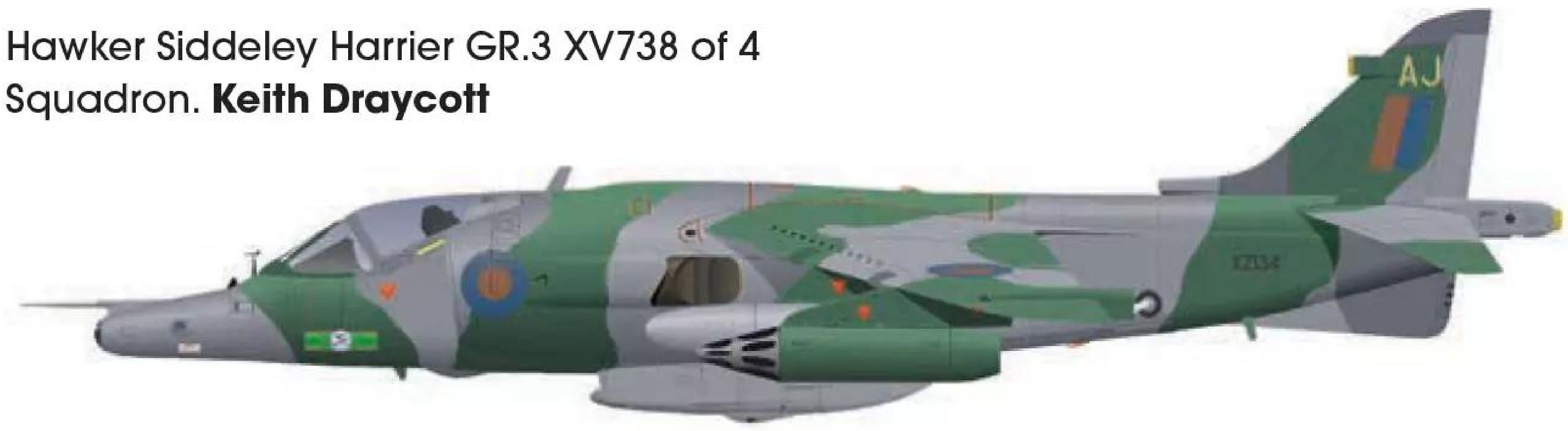
As the Harrier matured in RAF Squadron service, a number of shortcomings of the early aircraft were identified and dealt with through an ongoing modification programme.

The quest for more power was to be a continuous factor in the Harrier's development, the next step being the Pegasus 11 Mk 103 which had an additional 1000lb of thrust, bringing it up to 21,500lbs (9752kg) total. The ability of the Harrier to identify and engage battlefield targets from low level and at longer ranges was greatly enhanced by the addition of a Laser Ranger and Marked Target Seeker (LRMTS) sensor package. There was nowhere else to put this on the airframe other than in a much extended nose, giving the aircraft quite a distinctive profile.

The new aircraft with the LRMTS and Pegasus 103 was designated the Harrier GR.3 and re-equipped all four Harrier squadrons during 1975. The GR.3 also had a new integrated electronic countermeasures system to improve survivability against an integrated anti-aircraft defence. In total 61 of the Harrier GR.1 and 1A aircraft built were converted to this standard, and 40 new airframes were built.

Hawker Siddeley Harrier GR.1As of 1 Squadron over Belize in Central America. The closer aircraft has the new wraparound scheme adopted in the mid-1970s, but some of the stores are still in the light grey of the earlier pattern. **BAE SYSTEMS**

Three Hawker Siddeley Harrier GR.3s of 1 Squadron, XW919/03, XV752/04 and XZ992/05 in formation over the German plains on deployment in 1980. Two years later these aircraft would be on board a ship off the Falkland Islands. **BAE SYSTEMS**

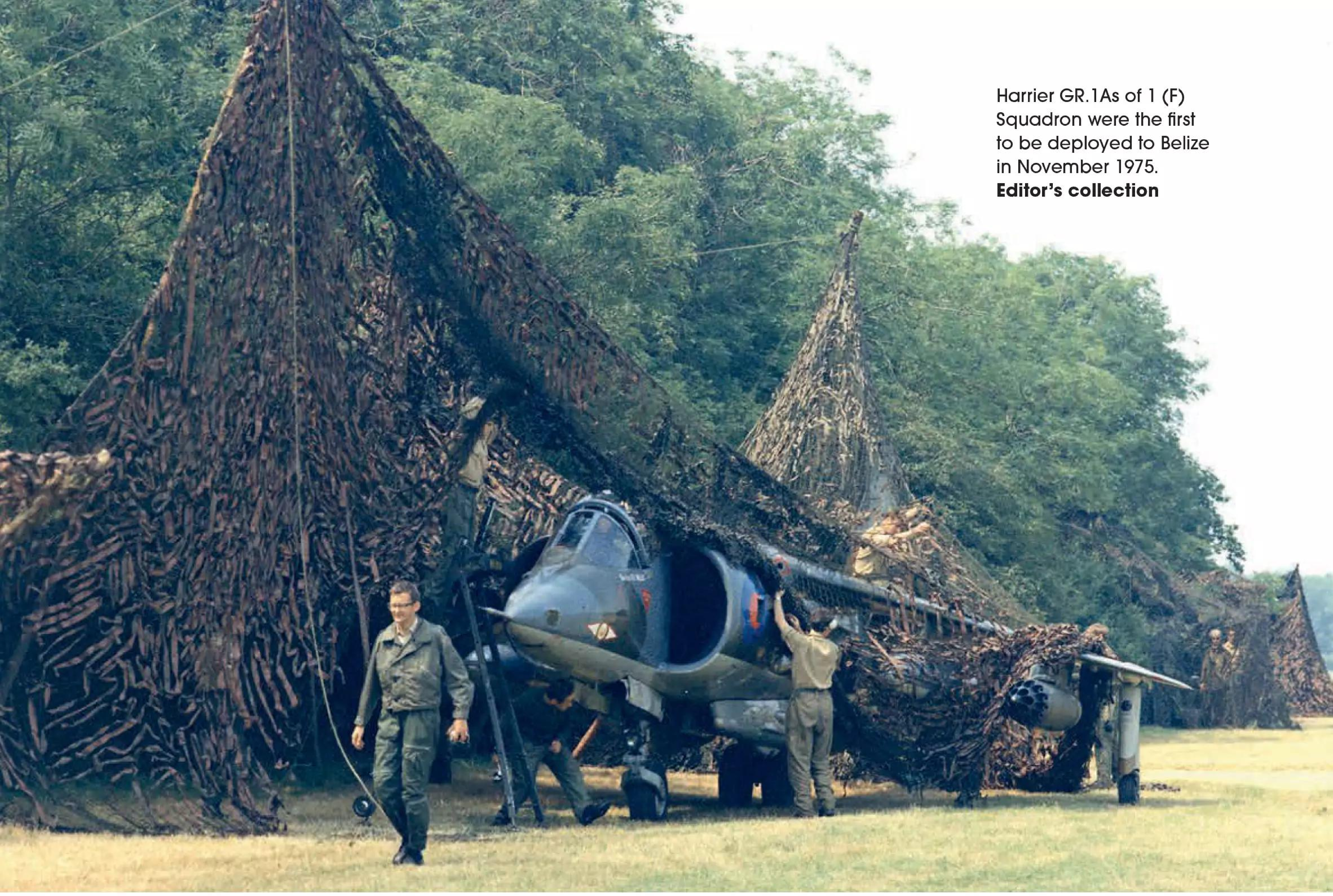

Hawker Siddeley Harrier GR.3 XV738 of 4 Squadron. **Keith Draycott**

A Hawker Siddeley Harrier GR.3 makes a short take off from a field in front of its hide in Germany. **François Prins**

With the advent of the GR.3 the Harrier truly matured as a weapons system. A new unit was formed, 1417 Flight, a detachment of Harriers to operate in Belize to deter aggression from Guatemala. It continued to operate until disbanded in 1993 and was the last operator of the GR.3. The full story of this unit is told later in this issue.

When 3 and 4 Squadrons moved to RAF Gutersloh after the withdrawal of the RAF Lightning air defence units previously based there, 20 Squadron was disbanded due to Gutersloh having insufficient room for three squadrons. The aircraft were split between the other two squadrons, bringing complements to 18 Harriers each. 1 Squadron continued practicing deployability and exercising around the globe until, in 1982, it was suddenly caught up in the preparations for what would be the GR.3's finest hour, the Falklands War. ■

Words: Tim Callaway



Harrier GR.1As of 1 (F) Squadron were the first to be deployed to Belize in November 1975. **Editor's collection**

Frontline Harrier Belize

Even before they made the headlines during combat in the South Atlantic, RAF Harriers were called on to protect a remote British colony many thousands of miles from the UK, nearly five years earlier.

A No 1417 (Tactical Ground Attack) Flight Harrier GR.3 at Belize prepares for a patrol. **David Oliver**

Athough RAF Harriers first came to public prominence during the Falklands conflict, they came close to being used in action for the first time following one of Guatemala's periodical threats to invade the neighbouring British colony of Belize (formerly British Honduras) in November 1975, when six Harrier GR.1As of No 1 (Fighter) Squadron were sent to Central America to reinforce the British Garrison. Guatemala, which for more than 100 years had been laying claim to the colony that blocked its access to the Caribbean, withdrew its forces from the border and in April 1976, the Harriers returned to the UK.

However, by June 1977 they had returned following yet more threats from Guatemala, whose superior forces

A Harrier GR.3 taxies out from its hide at Belize, armed with SNEB unguided rockets and wearing its No 1417 Flight badge on the nose. **David Oliver**

included a squadron of A-37Bs and a number of T-33s. Belize is a country comprised mainly of jungle, swamp and mountains, with only one airport and few roads – ideal Harrier country – and following this latest threat, a permanent detachment of Harrier GR.3s was based there. The high-profile role of No 1417 Flight included low-level patrols within sight of the border, and although not fitted with Sidewinder AAMs, they carried out live weapons practice with cannon, SNEB unguided rockets, and 1000lb HE and cluster bombs, on the colony's isolated swamp ranges.

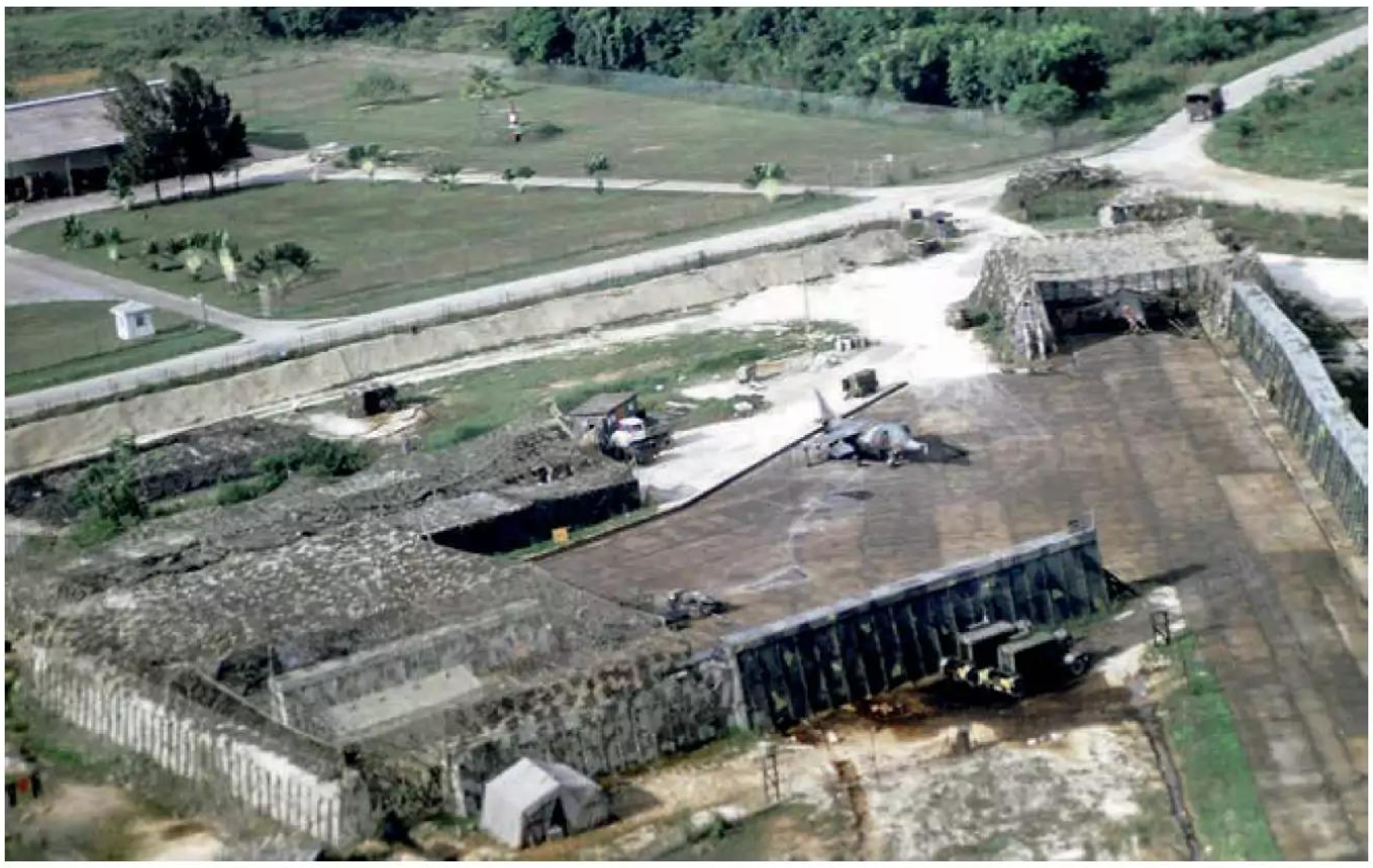
The flight was based at the international airport at Ladyville with some 300 RAF personnel and protected by four Rapier missile units. The Harriers operated from semi-permanent hides named using the NATO phonetic alphabet. Alpha and Bravo hides were set up in the grounds of the Belikin brewery outside the gates to the garrison while Charlie and Delta hides were set up on the other side of the garrison access road. Foxtrot and Golf hides were located around the airport fire station with Hotel, India and Juliet hides arranged around the access taxiway and the edge of the airport apron.

After operating as a rotating roulement for two years, the Harrier detachment was put on an even more permanent footing with the formation of No 1417 (Tactical Ground Attack) Flight from April 1980. Much flying was done, with plenty of flag-waving and sabre-rattling, with the aircrew enjoying the posting due to the lack of restrictions, and challenging missions. Eventually operations were confined to Charlie/Delta and Foxy/Golf hides which went through a slow metamorphosis to permanent semi-hardened hides with concrete surfaces and taxiways and block-built buildings which included accommodation, kitchen and bars.

The Harriers were drawn from Nos 1 (F) and IV (AC) Squadrons and rotated every six months via Goose Bay, Canada, and Bermuda. Three aircraft were lost while deployed to No 1417 Flight, one abandoned following a bird strike, another crashed into trees after failing to gain height during vertical take-off at Belize Airport, while a third struck trees near Georgeville. All three pilots ejected safely. Two more Harriers were severely damaged, one of which encountered a large vulture on approach to landing that tore straight into the intake, and another due to a brownout while attempting to land on a short airstrip on St Georges Cayes, one of the small islands off the coast of Belize.

A No 1417 Flight Harrier GR.3 fire its twin 30mm Aden guns at a live fire range in Belize. **David Oliver**

In 1991 the Guatemalan government eventually recognized the self determination of the Belizean people, 10 years after its independence. This statement meant a significant alternation in Guatemala's foreign policy. This step was followed in 1992 by a declaration of the Guatemalan president of the recognition of the independent state of Belize and the establishment of diplomatic relation between the two countries. Following this de facto declaration of peace, the Harriers, which were the last RAF GR.3s operated,



Two No 1417 Flight Harrier GR.3s in Alpha hide outside the gates to the Belize garrison. **David Oliver**

No IV (AC) Squadron Harrier GR.7s took part in the last deployment to Belize in 1993, Operation Warden over Northern Iraq and Operation Grapple and Allied Force over the former Yugoslavia in the 1990s. **via David Oliver**

were withdrawn from Belize in 1993.

By this time, the Harrier GR.5 was replacing the GR.3 in RAF service. Conceived as a joint venture by British Aerospace and McDonnell Douglas, the more powerful Harrier II could carry twice the weapon load of the GR.3 with a 50% increase in its tactical radius. Although the GR.5 entered service with No 233 Operational Conversion Unit at Wittering in May 1987, it was not considered combat ready when the UN-sanctioned Operation Desert Storm began in January 1991, and the Royal Navy carriers with their Sea Harriers were held in reserve.

The first Gulf War coincided with the first deliveries of the Harrier GR.7, an upgraded version with a day/night capability and the integration of 'smart' weapons. Service introduction, however, was plagued with teething problems that led to a period of grounding in 1991 and the effectiveness of a dedicated STOVL combat aircraft to be called into question. The Harrier made one last deployment to Belize in September 1993 when Harrier GR.7s of No IV (AC) Squadron flew to the former colony via Goose Bay in Canada, and Key West in Florida, airrefuelled by VC.10 tankers. This was another flag-waving exercise to demonstrate the RAF's ability to deter potential aggressors at short notice.

Nevertheless, with the break-up of the Warsaw Pact and the end of the cold war, some defence some planners argued that the Harrier's original mission – that of close air support for ground forces from makeshift forward operating bases as they made rapid advances on the set piece battlefield – was now redundant in the modern limited war scenarios.

This seemed to be borne out by the fact that small numbers of RAF Harriers flew from large fixed air bases in Italy and Turkey in support of UN and NATO no-fly zone operations Warden, Deny Flight and Grapple over Iraq and the former Yugoslavia. These limited engagements continued over Serbia culminating in the NATO operation, Allied Force in June 1999 during which Harriers from No 1 (F) Squadron had carried out 870 bombing missions.

However, as a result of the UK government's 1997 Strategic Defence Review, a lifeline was thrown to the Harrier community with the establishment of Joint Force Harrier (JFH) on April 1, 2000. JFH combined the Royal Navy's Sea Harrier FA.2 squadrons with the RAF's Harrier GR.7 squadrons under a joint command structure based within RAF Strike Command.

Golf hide at Belize had brick-built accommodation for No 1417 Flight personnel, and a bar. **via David Oliver**

The aim was to create a deployable force that could operate from RN aircraft carriers, RAF bases at home and abroad, and be deployed to forward operating locations worldwide. In fact, it was in the latter that the Harrier was able to reassert its reputation as the UK's premier attack aircraft. ■ *Words: David Oliver*

Charlie hide was one of six used by Belize-based No 1417 Flight Harrier GR.3s in the 1980s. **David Oliver**

The first ship-borne Harriers

The US Marine Corps AV-8A and the Royal Navy Sea Harrier FRS.1

WF
158387
MARINES
VMA-513

A Hawker Siddeley AV-8A of VMA-513, the first US Marine Corps Attack Squadron to operate the type. **US Marine Corps**

The ability of the Harrier to operate from ships had been recognised from the very beginning of the P.1127 development programme. However, once the naval version of the P.1154 had been cancelled, Royal Navy interest waned as the subsonic P.1127 did not meet the requirements of the time. Then, in 1968, the first service to order a naval version literally walked into the Hawker Siddeley chalet at the Farnborough Air Show...

A Hawker Siddeley Harrier GR.1 of 1 Squadron during sea trials on board HMS *Ark Royal*. Trials such as this proved the capability of the Harrier to operate at sea and prompted the development of the Sea Harrier. **BAE SYSTEMS**

The Kestrel and P.1127 programmes had elicited strong interest in the United States since their beginnings in 1957. The Pegasus engine had also been evaluated and six of the Kestrel aircraft from the tripartite programme had been taken back to America for study by the US Air Force and Navy. Several pilots from the US Marine Corps had also flown these aircraft, called XV-6As in the US, but all three services found them underdeveloped as military aircraft with limited payloads and range. The concept was found sufficiently interesting for the trials to take place, but nothing further was done after these were complete.

STOP ME AND BUY ONE!

Once the Harrier was in production for the RAF, promotional films of the aircraft under test reached the US Marine Corps, which realised this was a very different prospect from the earlier Kestrel. It was decided that the Harrier could now meet the Corps requirement for a close support aircraft, but it needed to know more about the reality of the programme and its potential. Typically of the Marines, they took direct action, and Col Tom Miller and Lt Col Bud Baker simply walked into the Hawker Siddeley chalet at Farnborough Air Show in 1968 and asked to fly the aircraft! After recovering from the shock, Hawker Siddeley arranged a series of trial flights, briefings and demonstrations which took place over the next three weeks.

The two pilots returned to the US with enthusiastic reports about the Harrier's suitability for naval operations. Since the US Marine Corps purchases its aircraft through the US Navy, a Navy team arrived at Dunsfold in February 1969 in order to make a more official evaluation of the Harrier. This evaluation was again positive, only the political dimension needed to be addressed in order for the Harrier to gain its first overseas customer.

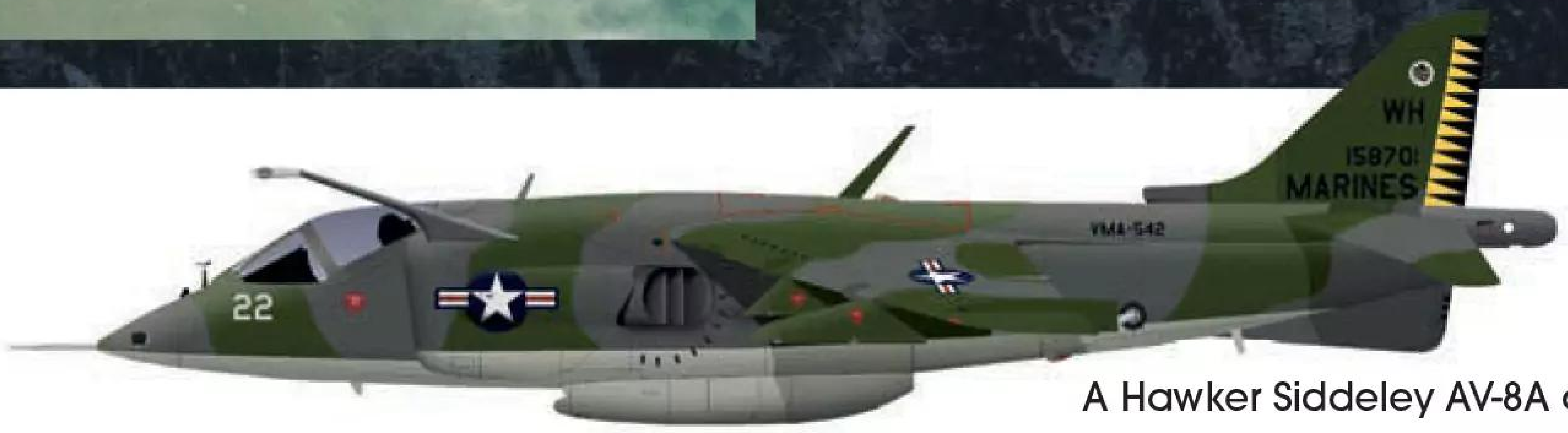
One of the major sticking points for the acquisition of the Harrier by any of the US forces was that of dependency on a foreign supplier for supply and support of a major weapons system. To eliminate this as a political problem, Hawker Siddeley began negotiations with a number of US aircraft manufacturers in order to find a partner to build the Harrier under licence. In this matter, the earlier cancellation of the P.1154 actually became an asset. The Royal Navy had chosen the McDonnell Douglas F-4K Phantom in place of the P.1154, and Hawker Siddeley had become the design and support authority in the UK for the Phantom. Since the two companies were already working together on the Phantom, it was a natural extension of this collaboration to invite McDonnell Douglas to participate in the Harrier programme. The two companies formalised a partnership in August 1969 with a view to McDonnell Douglas producing the 114 Harriers intended for the US Marine Corps.

A pair of Hawker Siddeley AV-8As of VMA-231, the unit that conducted a tour aboard the fleet carrier USS *Franklin D. Roosevelt*. **US Marine Corps**

Hawker Siddeley Sea Harrier FRS.1s of 809 NAS at Ascension Island in 1982 on their way south to join the Task Force. **Mel James**

US MARINE CORPS AV-8A/C UNITS

VMA-231 – AV-8A/C Harrier. 1973-1985.
VMA-513 – AV-8A/C Harrier. 1971-1986.
VMA-542 – AV-8A/C Harrier. 1972-1986.
VMAT-203 – Training squadron, equipped with AV-8A and TAV-8A Harrier. 1975-1987.



A Hawker Siddeley AV-8A of VMA-542. **Keith Draycott**

UNUSUAL POLITICAL RESULTS

In an unusual turn of events for such a major military purchase, the House Appropriations Committee of the US Government ruled that the Harriers would be cheaper to acquire if they were built at Kingston on the existing production lines. The new aircraft was designated as the AV-8A (Hawker Siddeley Harrier Mk 50) and the 102 examples built at Kingston were delivered between 1971 and 1976. An additional eight two-seat training aircraft, called TAV-8As (Hawker Siddeley Harrier Mk 54) were built and delivered in 1975 and 1976. Similarly, a partnership between Rolls-Royce and Pratt & Whitney to produce the Pegasus engine under licence as the F402 was never required, all the engines for all US versions of the Harrier have been built in the Rolls-Royce Bristol factory as it was far cheaper and more efficient to do so. Another first for the Harrier programme then, as pragmatism won out over politics.

The first US Marine Corps Attack Squadron converted to the AV-8A in 1971, using the first 12 aircraft ordered directly from Hawker Siddeley under special dispensation while the political arguments over production were still being ironed out. The squadron was Marine Attack Squadron 513 (VMA-513), which was commanded by one of the original US Marine proponents of the Harrier and now a full colonel, Bud Baker.

The squadron was to operate from the USS *Guam*, which was an amphibious assault ship converted for the purpose of operating the AV-8As. In this guise, the *Guam* was known as an Interim Sea Control Ship. The Sea Control Ship (SCS) concept was proposed by Admiral Elmo Zumwalt and was intended to be a light carrier in the 15,000-ton class operating Harriers and helicopters in support of US Marine Assault Forces and supplementing the huge fleet carriers of the US Navy.

This first squadron was the beginning of a massive programme of experimental and developmental flying in order to develop doctrine and integrate the Harrier into the Marine Corps. This deployment proved successful, and the SCS concept found favour with a number of navies, including the Royal Navy. The Invincible class 'through deck cruisers' were generally similar to the SCS proposal and made such a vital contribution to the Falklands War.

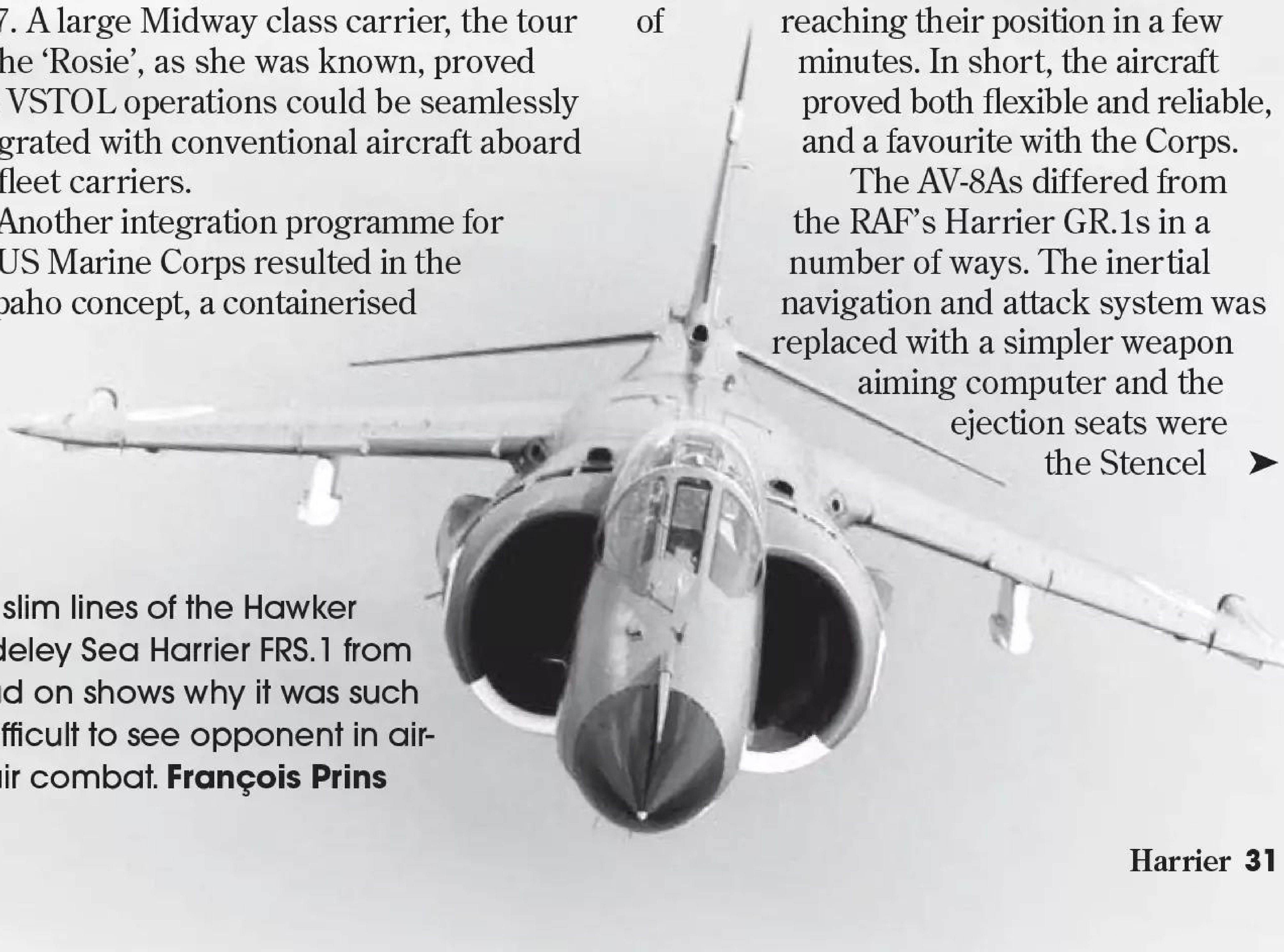
DEVELOPING AND INTEGRATING

Exercises and deployments to prove the suitability of the AV-8A to operate from all kinds of US military vessels included a tour of 11 months by the 14 AV-8As of VMA-231 aboard the USS *Franklin D. Roosevelt* between June 1976 and April 1977. A large Midway class carrier, the tour on the 'Rosie', as she was known, proved that VSTOL operations could be seamlessly integrated with conventional aircraft aboard the fleet carriers.

Another integration programme for the US Marine Corps resulted in the Arapaho concept, a containerised system that could rapidly convert a fast civilian container ship into a carrier for AV-8As and helicopters. Again, this was a concept that Britain used in the Falklands with ships such as the *Atlantic Conveyor*.

The Marines also developed the close air support capabilities of their Harriers for Marine forces ashore after an assault. Rapid deployment forward air bases were developed, with light maintenance facilities, to be set up within 24 hours of an assault and to move forward as the land battle progressed. The idea was to keep the AV-8As operating from no more than 20 miles from the Forward Edge of the Battle Area, or FEBA. This would shorten sorties and increase the sortie rate by the aircraft, and give the Marines on-call air support capable of reaching their position in a few minutes. In short, the aircraft proved both flexible and reliable, and a favourite with the Corps.

The AV-8As differed from the RAF's Harrier GR.1s in a number of ways. The inertial navigation and attack system was replaced with a simpler weapon aiming computer and the ejection seats were the Stencel ➤


The slim lines of the Hawker Siddeley Sea Harrier FRS.1 from head on shows why it was such a difficult to see opponent in air-to-air combat. **François Prins**

SEU-3a instead of the Martin-Baker unit. From the outset, the outer pylons of the AV-8As could carry the AIM-9 Sidewinder heat-seeking missile for self-defence, a capability only later added to the RAF aircraft. All magnesium components and other combustible materials were removed from the airframe, and US radios and Identification Friend or Foe (IFF) equipment were fitted.

The majority of the AV-8As had been fitted with the 21,500lb (9752kg) thrust Pegasus 11 Mk103 when built, the same engine that powered the RAF's GR.3 rather than the earlier Pegasus 10 Mk102 from the GR.1As. As a mid-life upgrade, starting in 1979, 47 of the AV-8As were upgraded to AV-8C standard, all with the improved Pegasus 11 Mk103, known as the F402-RR-402 in the US. The AV-8Cs had an Electronic Counter Measures (ECM) suite added and a new inertial navigation system. The Vertical Take Off performance was improved by the addition of Lift Improvement Devices and several major airframe components were replaced to effectively extend the service life of the aircraft at minimal cost.

In 1985, these AV-8As and Cs were steadily replaced as the new AV-8B Harrier II began to enter service. This was essentially a completely different aircraft and is described later, but it was a joint product of British Aerospace, of which Hawker Siddeley was now a part, and McDonnell Douglas, whose long involvement in the Harrier programme finally paid dividends with the development of the new aircraft.

The Sea Harrier FRS.1 could carry a pair of Sea Eagle anti-ship missiles. **BAE SYSTEMS**

ENTER THE SEA HARRIER

While all this development was going on for the US Marine Corps, other customers were interested in acquiring the Harrier. While the other overseas customers will be dealt with in a separate article, one stands out as it required the first major re-design work on the aircraft since the original P.1127 concept. The customer was the Royal Navy, and the new aircraft was the Sea Harrier.

The Royal Navy, like the other services, had suffered from the defence cutbacks, particularly when, in 1966, the CVA-01 large aircraft carrier programme was cancelled. The last post-war carrier in service, HMS *Hermes*, had been recommissioned as a helicopter carrier in 1973 and was no longer able to operate conventional aircraft.

The situation changed with the development of the 'through deck cruiser' concept of the early 1970s. Many observers believe the term was coined to avoid use of the words aircraft carrier and therefore make their political survival and funding that much more likely! In truth, they were small aircraft carriers aimed at operating helicopters in the anti-submarine warfare role. The ruse worked and in 1973 the first ship of four of the new Invincible class, HMS *Invincible*, was ordered.

Even though the British Government had intended to abandon the idea of a UK aircraft carrier, it was obvious that the new ships could also operate V/STOL aircraft, so in May 1975, a naval version of the Harrier was authorised for development. The ship's designs were modified to accommodate the new aircraft. This included the provision of a ski-jump take-off ramp to improve the short take-off performance of V/STOL aircraft operating from the short 558ft (170m) decks.

In essence, both the ships and the aircraft were the products of a well-played political subterfuge as the financial climate in Britain was hostile to the acquisition of expensive capital ships. The architects of this cunning plan were to be completely vindicated only a few years later, when the Sea Harriers operating off HMS *Hermes* and HMS *Invincible* were to successfully provide the only possible fighter cover to the Task Force sailing to retake the Falkland Islands.

Royal Naval interest in V/STOL aircraft had begun with the first trials of the P.1127 aboard HMS *Ark Royal* in 1963. Development of the supersonic P.1154 had included a strictly naval version, and its performance was exactly what the RN needed at the time. However, when this project was cancelled, interest in V/STOL waned, even with the further successful trials of the Kestrel aboard HMS *Bulwark*. However, the success of the Harrier in RAF service and the naval integration of the AV-8A already being developed by the US Marine Corps rekindled Royal Navy interest in the type.

MAKING A FIGHTER

To meet the requirements of the Royal Navy for a fighter, reconnaissance and strike aircraft, in that order, everything forward of the air intakes had to be redesigned. As a fighter first and foremost, the Sea Harrier needed a radar and improved visibility from the cockpit for the pilot. The cockpit was raised and fitted with a bubble canopy and the nose was lengthened and tapered to accommodate the Ferranti Blue Fox radar. The ability to carry the AIM-9 Sidewinder heat-seeking air to air missile on the outer wing pylons, like the AV-8A, was included from the start. The airframe changed in detail as many parts were now made from more corrosion-proof alloys and anti-corrosion coatings were added to much of the structure to improve the protection against exposure to salt water and a marine environment. The resulting aircraft proposal was ordered by the Royal Navy in 1975, the 24 aircraft being designated Sea Harrier FRS.1.

By the time the prototype Sea Harrier FRS.1 flew for the first time at Dunsfold on August 20, 1978, the order had already been increased to 34 aircraft. Eventually 54 of the type were built in two main production runs between 1978 and 1983 and 1985 and 1988.

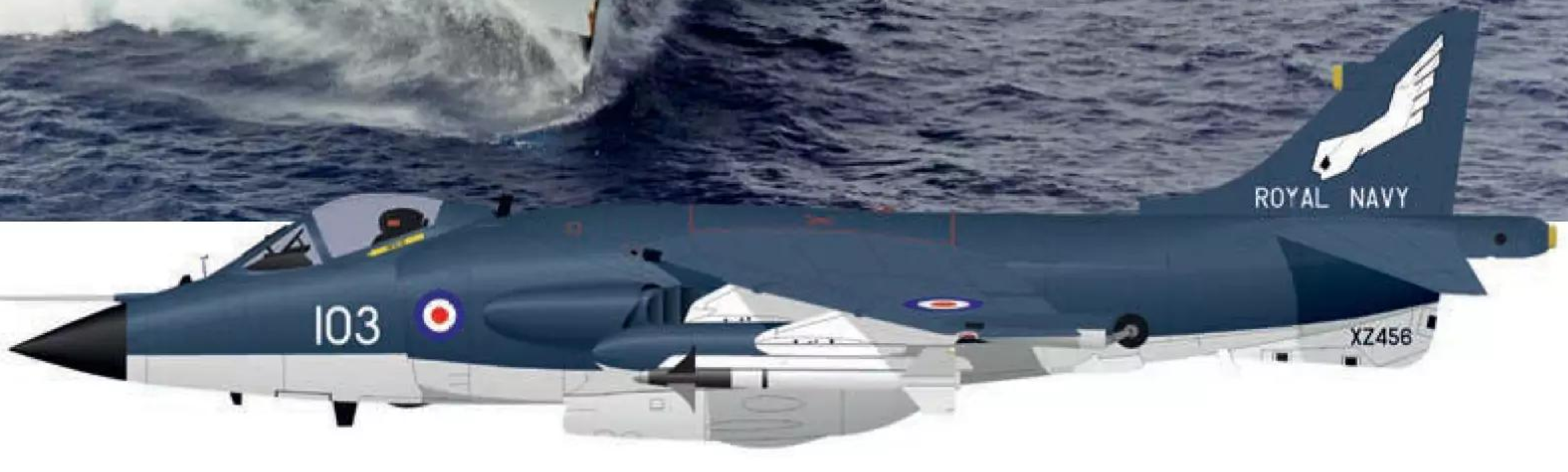
The first three aircraft off the Kingston production line were intended purely as development airframes and were used to test the radar and other systems, as well as taking part in weapons clearance trials. These three were XZ438, 439 and 440, and were all equipped with a new version of the Pegasus engine. It was essentially still the Pegasus 11 of 21,500lb (9752kg) thrust, but had a new version number, the Mk104. This new engine, like the airframe, had a number of components made of corrosion resistant alloys and other materials, but otherwise was identical to the engine of the GR.3 and AV-8C.

INTO SERVICE AND OFF TO WAR

The first production aircraft were delivered to the British home of Naval Aviation, RNAS Yeovilton in Somerset, early in 1979. This aircraft was to form the basis of the Intensive

Hawker Siddeley Sea Harrier FRS.1s of 801 NAS recover back aboard the USS *Dwight D. Eisenhower.* **US Navy**

A Hawker Siddeley Sea Harrier FRS.1 of 801 NAS launches from the ski jump of HMS *Invincible*. **BAE SYSTEMS**



A Hawker Siddeley Sea Harrier FRS.1 of 899 NAS. **Keith Draycott**

Flying Trials Unit (IFTU), which was aimed at testing every system of the new aircraft and developing operational doctrine and procedures for it. The IFTU became 899 Naval Air Squadron (NAS) in March 1980 and was to act as the headquarters for the Sea Harrier, testing developments before introducing improvements and modifications to the other units.

The first operational squadron formed was 800 NAS under the command of Lt Cdr Tim Gedge, on March 31, 1980. The unit first went aboard the brand-new HMS *Invincible* before transferring, in June 1981, to the HMS *Hermes*, which had been modified with a ski jump take-off ramp as part of a refit. Only 10 months later, the second squadron, 801 NAS, formed at Yeovilton and went aboard HMS *Invincible*.

One last Sea Harrier squadron formed, but for a very short period. 809 NAS formed at Yeovilton, again under Lt Cdr Tim Gedge, and its eight aircraft and pilots were sent south to join the Task Force heading for the Falklands. On arrival with the fleet, half the squadron was sent to each carrier to operate as part of the carrier's own squadron. The squadron was reunited aboard HMS *Hermes* and transported back to Britain at the end of the war, before returning to patrol the islands aboard the brand-new HMS *Illustrious*. With the arrival of RAF F-4M Phantoms at the much-extended RAF Stanley, HMS *Illustrious* returned to Britain in December and 809 NAS was disbanded on the 17th of that month.

During the Falklands War, the pilots and aircraft of 899 NAS were also despatched to the fleet, three of its aircraft joining 801 NAS on board HMS *Invincible* and seven joining 800 NAS on HMS *Hermes*. The remaining pilots and groundcrew of 899 NAS remained at RNAS Yeovilton to bring more Sea Harriers into service in case replacements were needed rapidly. A full account of the Sea Harriers' operational use in the Falklands War appears later in this issue.

Immediately after the Falklands War, the Sea Harrier FRS.1 was modified to be able to carry the large and powerful Sea Eagle antiship missile. From 1984, the Sea Harrier was the subject of a considerable mid-life upgrade, largely due to the lessons learned in the conflict, to become the FRS, later FA.2. The first of the new aircraft flew in September 1988 and was delivered on April 2, 1993.

Prior to this, the Sea Harrier FRS.1 saw combat again during the 1991 Gulf War, where they flew escort missions as well as strikes against Iraqi ground targets. After the conflict, they flew combat air patrols to enforce the nofly zone over Southern Iraq. From 1991 to 1995, the Sea Harrier FRS.1s were again in action, this time over Bosnia. Aside from conducting air strikes against Serb Forces, the Sea Harriers also flew combat air patrols in support of Operation Deny Flight and Deliberate Force.

During these missions, a Sea Harrier FRS.1, XZ498, flown by Lieutenant Nick Richardson of 801 NAS, was hit by a surface-to-air missile on April 16, 1994, and he was forced to eject. Nick escaped with the SAS patrol he had been working with, all of them being picked up by a French Puma helicopter.

On February 18, 1995, as part of Operation Deny Flight, 800 NAS made the last operational sortie by a Sea Harrier FRS.1. The majority of the surviving airframes were converted to the new standard, so very few still exist, but the Sea Harrier FRS.1 served the Royal Navy extremely well through three wars and a period of great change in the makeup of the British Armed Forces. ■

Words: Tim Callaway

Eagles & Harriers

‘The large and the small of it’

Prior to the Falklands War, USAF F-15 Eagle pilots from Bitburg AB in Germany provided dissimilar air combat training for RAF Harrier pilots. One of these was Robert I. ‘Scout’ Winebrenner, who here recounts his personal experiences with Britain’s vertical take-off jet.

Before the spring of 1982, most Eagle pilots had little exposure to the Harrier, and as a relatively new squadron pilot with the 53rd Tactical Fighter Squadron in Bitburg AB, Germany, I was no exception.

We saw them only occasionally as part of the AAFCE target of opportunity training programme. The encounters were made more rare by the fact the Harriers were mostly to be found in the northern Low Fly Areas (LFAs) one to three, and since Bitburg’s mission focus was more in four Allied Tactical Air Force (the southern half of Germany), we preferred to beat up LFA 7 with the Neuburg Phantoms and Söllingen CF-104s.

When we did come across Harriers, the first problem was actually seeing them. The Harrier presented an extremely small and compact visual profile – a real contrast to the Eagle’s ‘titanium overcast’ – and was well camouflaged for low level flight over the North German Plain. Especially when it was a little murky down low, I stared through my HUD’s target designator box many times at a Harrier, wondering if there really was an aircraft in there. Moreover, I think many of us hadn’t even heard of the Falkland Islands before that time.

Suddenly, we were confronted with some educational opportunities on both.

Harrier pilots had been trained to use their wits and tactics to completely avoid air-to-air confrontations. However, speedy improvisation in the face of the Falklands War found them with a new weapon (the AIM-9), potentially a new mission and very little background or training to support either.

Against this backdrop, the GR.3 pilots of 4 Squadron appeared at Bitburg with a vague idea of what might be required of them – being pressed into service as an air defence platform for the British expeditionary force. They were requesting our assistance but had only a very rough idea of what training they really needed, few resources and dreadfully little time.

The purpose of the training was ostensibly a hasty course in basic AIM-9L employment as well as defensive tactics against the air-to-air weaponry of the Argentine A-4s, namely 20mm cannon and early AIM-9 variants. This was all with an eye to increasing the chances of a successful encounter with an A-4 or even warding off an attack on friendly forces.

Additionally, Harriers would play a key role even after recapturing the islands, as the runway at Stanley was unsuitable for any other type of fast jet without some improvement; that meant Harriers near-term as the land-based ‘fighter’ force.

Over the next days, my squadron flew a number of training missions with 4 Squadron. These were typically visual starts, with about 6000 Separation, offensive and defensive, with F-15s simulating – to the extent possible – the flight characteristics and weapons of the A-4. To this end, the Eagles used military power only (no reheat), and restricted AIM-9 shots to within 60° of the tail. We continued to use our radars for flight safety enhancement but didn’t play any radar missiles or slaved (off-boresight) Sidewinders. We immersed ourselves temporarily, but completely, in the role of training aid.

➤

The diminutive Harrier GR.3 was a difficult target to spot, particularly at low level where its camouflage was designed to work best. As a fast agile ground-attack aircraft, it gave defending fighters a headache through its small size. **BAE SYSTEMS**

With the Harriers on offence, it was largely a point-and-shoot exercise to practise getting a quick Sidewinder shot off the rails. Thereafter, the Eagle would typically enter an energydepleting defensive turn, and the Harrier would attempt a reposition for a follow-up shot. The greatest difficulty the Harrier pilots had in these exercises was recognising the limits of forward-quarter minimum range or beam aspect high angular rate Sidewinder shots. While the AIM-9L was very much a point-andshoot weapon, it still had its limitations, and the Harriers lacked the radar ranging and dynamic launch envelope presentations common in fighter aircraft.

Pilots had to visually and quickly estimate whether a shot was within parameters or not. Anyone from a no-radar ground-attack background would have been similarly challenged, but 4 Squadron tackled the problem admirably, and I like to believe the training was quite helpful, in the air as well as in the extended briefings and debriefings.

The Harriers starting on the defensive presented a completely different problem: Defeating a possible early-generation AIM-9 shot and separating from the fight, or bestcase, reversing fortunes and killing the attacker. In this scenario, the Harrier pilots were very eager to introduce us to VIFF – or Vector in Forward Flight. In theory, this manoeuvre/technique was intended to quickly rotate the nose of the Harrier toward the attacker, rapidly increase closure, and force a flight path overshoot. In theory. What we observed in the air was singularly unimpressive. The VIFFing Harrier essentially turned into a motionless strafe rag.

If the attacker's gun pass was unsuccessful, perhaps only one vertical reposition was needed before the Harrier was forced to regain airspeed, giving the attacker a heart-of-the-envelope Sidewinder opportunity. Even if the VIFF did cause a flight path overshoot, the Harrier – then practically stationary – lacked the necessary energy or nose-pointing ability to take advantage of the situation, or the airspeed to effect a successful separation.

The F-15 was a massive aircraft by comparison, its 42ft 9.75in (13.05m) wingspan being nearly twice the size of the Harrier's 25ft 3in (7.7m), giving it over three times the wing area of the British jet. **US Air Force**

After these missions, I believe we unanimously suggested to the Harrier pilots that their defensive chances would be better served by a more normal turn, keeping as much airspeed and energy as possible, preserving the ability to perform last-ditch missile or gun evasion. The HUD camera reviews in this regard were really quite compelling.

THERE IS A CAVEAT TO THIS

Owing to airspace restrictions, this training was all conducted in TRAs 204 and 205 above 10,000ft where the Harrier was very much out of its element. It could be that VIFF effectiveness at low altitude is better, but I remain a sceptic to this day.

Training complete, or more accurately, time running out, 4 Squadron thanked us and went on to bigger and better things. Our encounters with Harriers became even more infrequent owing to their additional deployment commitments. I crossed paths with them again a few years later in Decimomannu, Sardinia.

Pilots and aircraft from 4 Squadron went to Bitburg to develop fighter tactics for use in the Falklands War, where it was intended that GR.3s would be armed with the AIM-9L Sidewinder missile. **Editor's collection**

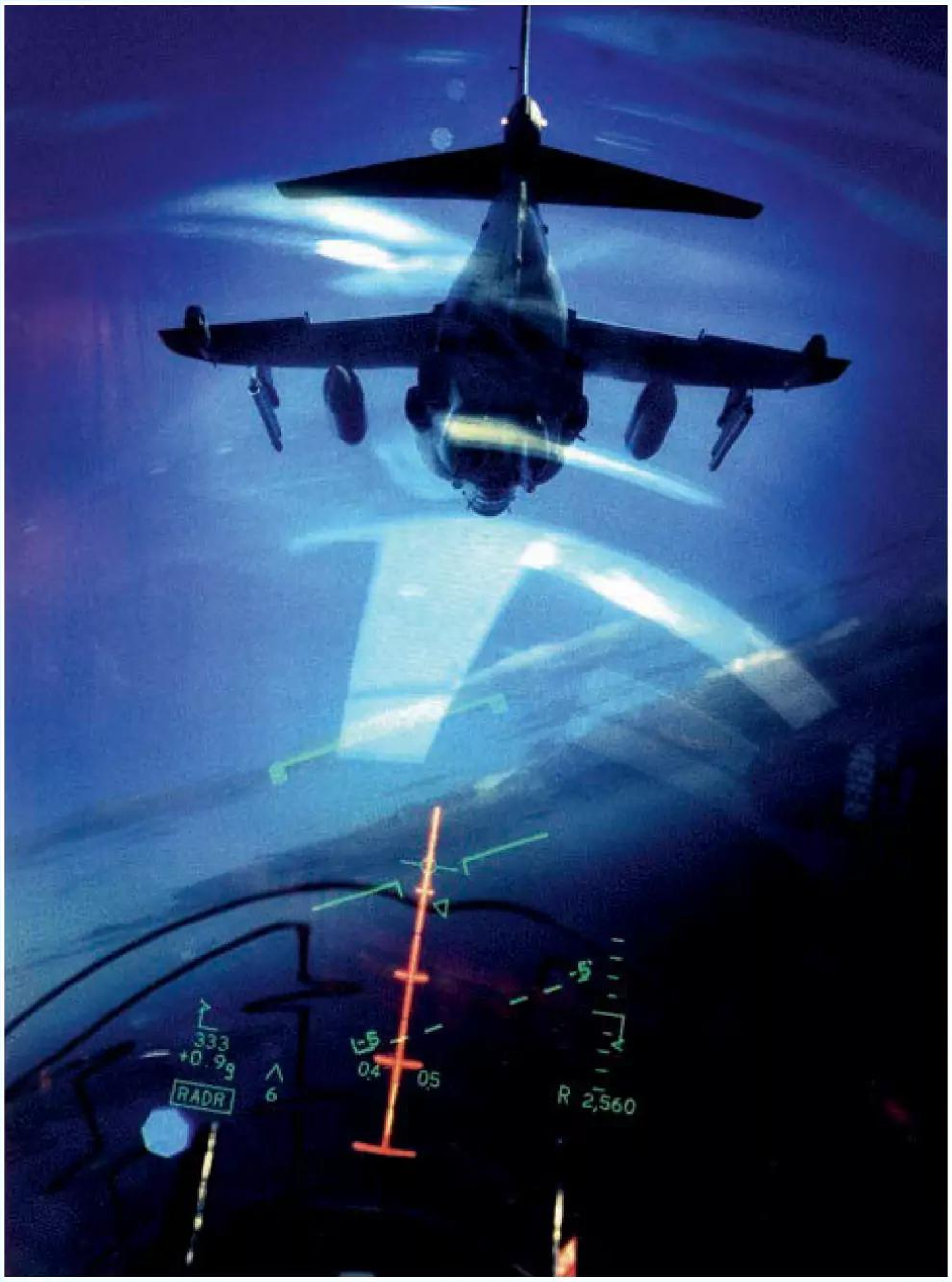
TRADING RIDES

There was normally some close cooperation and camaraderie between the British and American detachments at 'Deci.' This also had a geographical element: The British and American operations buildings were in close proximity, as were the officers' quarters. The 527 AS Aggressors and the British detachment typically provided the lion's share of our dissimilar air combat training (DACI) opponents. On this particular occasion, in January 1984, the British had a detachment of Harrier GR.3s at Deci, primarily using the air-toground range at Capo Frasca.

That did not prevent us from finding some way to benefit from each other's presence. Even if DACT in D40 was not in the cards, the detachment commanders agreed to trade some back seat rides in the respective twoseat variants. I expressed interest and was thrilled to be selected to spend the afternoon with the RAF detachment for a ride in the Harrier T.4. There I met up with Flt Lt Nick Gilchrist, who was part of the 1 Squadron Falklands deployment a few years earlier.

Before the briefing, I received egress training and ejection seat familiarisation. Then I was fitted with the necessary personal equipment. Sadly, the British and American helmets, masks, g-suits, etc. are completely incompatible with each other (the helmet... comfortable but far too heavy, especially for a high-g fighter. The g-suit's okay... why can't they make the mask a little bigger? Oh well... at least it's better than the French stuff).

We briefed up a four-ship low level navigation sortie over Sardinia ending with a showcase vertical landing. After a short walk to the jets, I immediately climbed in and started strapping in, since I needed just a little more time: The Martin-Baker seat in the Harrier was arguably more complicated to get into than the ACES II in the Eagle, especially for the unpractised. It certainly is a tight fit.



In line astern in a Sea Harrier FRS.1, looking through the head-up display. The author flew a Hunter fitted with the Blue Fox Radar and found, while it was limited, it was easy for a single pilot to operate. **BAE SYSTEMS**

The view from a two seat F-15 cockpit. Even with the superb view afforded the pilot from the well-designed cockpit, the Harrier was a tricky opponent to find. **US Air Force**

Nick finished the walk-around of ZB600 and climbed up to point out some additional cockpit features and review a few emergency functions (you needn't worry, Nick, I thought, I won't play with any red guarded switches). I looked up and noticed the detonation cord. It's supposed to be faster than jettisoning the canopy, I thought. At low altitude, that's probably more important. Little did I know Nick would personally check out that feature just a few months later when his engine disintegrated during an airshow in Aschaffenburg, Germany.

We cranked the engine and pulled chocks after an impossibly short time. Wow! We were rolling already. The Eagle pilot needs a lot more time after engine start to run through an ever-growing list of avionics builtin test (BIT) functions.

"Deci tower, Bentley section to line up."

"Bentley, you're cleared to line up and cleared for takeoff, runway 35. Wind 020 – 13."

"Bentley acknowledged, cleared for takeoff."

The lead pair taxied halfway down the runway, we were in the number four aircraft and lined up centred on our side of the runway. A brief run-up, a release brakes signal, and we accelerated quickly down the runway. At a time that seemed unnaturally early to me, Nick moved the nozzles to approximately the 45° position and the Harrier staggered into the air, but continued to gain speed. As it did, the nozzles were slowly adjusted back to the 0° position, we spread apart, and were already in four-ship card formation before passing the airfield boundary. That was impressive.

Nick let me have plenty of stick time flying around the island – it was easy enough to fly formation, and the view from the back was not as poor as in several other aircraft I was familiar with. The high wing loading allowed a decent ride at low altitude and high speed. The compactness of the aircraft started to have an effect on me... I'd never felt that small in an aeroplane before...

After a circle around the island, we approached Alpha North and joined the visual circuit. The T.4 had less fuel than the GR.3, and after reaching hover weight there was really only enough time and fuel for one approach and vertical landing.

On our approach, Nick moved the nozzles to 90° and started to blend in power. He explained how the throttle was geared to make finer adjustments near the full power setting, and the importance of the 'weathervane' on the nose of the aircraft. As the different 'mission complete' lights started to illuminate, he remarked "and now it is time to land!"

The Harrier balancing precariously on a cone of thrust, Nick lowered the T.4 gently, but expeditiously, to the runway. As we were taxiing back in, he explained that the last flashing fuel light to illuminate represented about 30 seconds of hover time remaining.

Overall, a most interesting experience for an Eagle pilot – very, very different to our type of flying.

A few days later, it was time to reciprocate, and the detachment commander determined that since I'd had the benefit of the ride in the Harrier, I should rightly fly the 'Tub' that day for the RAF guest pilot. As it turned out, who should show up but Nick Gilchrist! We thought that a nice coincidence, and then set out to accomplish the seat and egress training, and get him outfitted with the necessary kit.

It was a bad weather programme day, the ACMI range was unusable below 30,000ft, and the US detachment was essentially the only one flying. We briefed a 1v1 similar BVR to high-altitude BFM mission. Based on my experience a few days earlier, I'm sure Nick was wondering why we needed to walk to the jets so early and spend so much time with engines running before taxiing, but polite as he was, he didn't say anything. The bad weather meant I needed to fly essentially the entire instrument departure out the 330° radial, until we finally got into clear air, did our checks, and split north-south.

"All right, Nick – one demo, then it's all yours."

"Perfect."

"Separation 38 miles."

➤

The Sea Harrier FRS.1 was an improved naval fighter version of the early 'small wing' Harrier. **BAE SYSTEMS**

The performance of the F-15 with its pair of Pratt & Whitney F100 turbofans can only be described as exhilarating. 50,000lb (222.4kN) of thrust in afterburner as opposed to the 21,500lb (95.6kN) for the Pegasus on the Harrier meant the Harrier pilots had to pick their fights with care and provided dissimilar combat training invaluable in the Falklands conflict. **US Air Force**

"Lead's ready."

"Two's ready."

"Turn in, fight's on."

Once steady on north, I said "let's step out a little bit," and selected about 1/2 reheat, which quickly accelerated us to about 1.2 Mach. I talked Nick through what I was doing with the radar, locating the opponent, locking, and briefly explained the plethora of information available. We shot a long-range Sparrow, and checked starboard to put the target 55° left on the scope: A so-called F-Pole manoeuvre designed to increase the enemy missile time-of-flight (TOF) and also increase range to the target at missile fly-out. I pointed out the predictive TOF display, and noted when it reached zero. "With any luck at all, that target would no longer be with us."

Nick was already amazed just to be flying above 30,000 – he was not at all prepared for what was going to happen next.

As the Sparrow timed out, we quickly turned in, ramped down, and reduced power to idle in an attempt to deny a Sidewinder shot; then, at minimum range, full reheat and a slicing lead turn into our opponent. The radii are larger and there's a lot more buffet, but an Eagle can still turn quite respectably in the 30s. The fight went two-circle with some altitude differential, and thanks to a vertical-scan radar lock, in no time at all we sent away a dogfight-mode Sparrow and a forward-aspect Sidewinder. Nick blurted: "What a fantastic killing machine!"

The Harrier GR.5 was the first of the RAF's 'big wing' versions. **BAE SYSTEMS**

"Chevy, knock-it-off."

"Two, knock-it-off."

"Okay, Nick... you've got the jet. Just point us south for now. When we turn in, I'll have to run the radar for you."

Nick chuckled: "Let's step out a little bit." I liked that. I think he was repeating that phrase for the rest of the week. Engines with reheat apparently had a certain appeal.

In the meantime, Nick seemed to be enjoying himself immensely just flying. He kept weaving back and forth, pointing the nose here and there, doing an occasional aileron or barrel roll, muttering: "This is great!" He got two engagements in, but didn't seem to care too much for the BVR game.

"Nick, we need to be shooting now."

"Well fine, then. Fox One... or whatever it is you chaps say!"

What he did want to do was get a tally-ho and turn. So, we deliberately stayed about 20-30° nose off in the terminal phase so Nick could see better, and I talked his eyes onto the bandit.

"Tally HOOOO!"

"Start turning now!" I prompted. In the 30s at around the Mach, it really was difficult to lead turn too early.

"Ha! Look at this!" Nick had the throttles plugged in the northwest corner and was pulling to the buffet. Even padlocked on the bandit, I was impressed with his natural feel for what was energy sustaining, or energy depleting.

"Reverse now! Lead turn him the other direction!" I urged. "Puuuuuull! Pull to his high six now!"

Nick howled with enthusiasm as we entered the beginnings of a very large rolling scissors, but we had to knock-it-off prematurely as we were too rapidly approaching the solid cloud deck below.

"Chevy 2's joker."

"Roger, we're out of range time anyway, join it up. Playground, we're RTB."

Nick was still laughing.

We checked in with Mirto Radar and stayed in close formation inbound on the R-265° until breaking out of cloud, halfway down the Iglesias valley. After coming to the overhead and splitting off our number two, Nick took us around the circuit, re-entered at Alpha South, and brought us back to the overhead, where I took the controls again for the full stop landing.

"No vertical landings with this one," said Nick.

"True, but almost vertical take-offs."

"How long's the takeoff roll?"

"The Streak Eagle used about three or four hundred feet – in our normal combat configuration we need about 900 or 1000."

"Pfffft. Amateurs!"

SEA HARRIERS

My next close encounters with the Harrier came at Decimomannu again, but flying DACT in the ACMI range against Sea Harriers.

This occurred in September 1984 and again in May 1989. On the latter occasion, I gained a bit more appreciation for the capabilities and limitations of the Harrier's Blue Fox radar through a flight in the Hunter T.8 Sea Harrier trainer (XL603).

This aircraft was fitted with Sea Harrier radar and navigation kit to enable new pilots to train with the equipment in the air before their first flight in an actual Sea Harrier, of which there were no two-seat training versions.

The Hunter ride was interesting in and of itself, but I did pay attention to familiarise myself with the radar.

Working with the Blue Fox reminded me in function and performance of the earlier APQ-120 (USAF F-4) radar, both having synthetic displays, but no clutter rejection or doppler processing, and thus no look-down capability. The detection range was also less than I expected. The Blue Fox was lacking a CW illuminator or any means of supporting a radar missile, however, the controls were easy enough to use and clearly more optimised for single-pilot operations.

I had to assume that the violent electronic hum in the intercom – which changed pitch according to engine speed – would not be present in the actual Sea Harrier. I hoped not!

The radar gave the Sea Harrier some ability to intercept targets in night/all-weather, look-up situations, but lacking a radar missile, weapons employment was still limited to clear air and the comparatively short ranges of the AIM-9L Sidewinder.

The DACT was in both cases with the FRS.1 variants; the contract for the FA.2 had only been signed in December of 1988, and the improved aircraft with Blue Vixen radars and support for the AIM-120 wouldn't enter fleet service until 1994. That left the Sea Harrier configuration on these occasions as two podded 30mm cannons and four AIM-9 Sidewinders, as by 1989 all had been fitted with the additional missile rails of the Phase I Update.

We would normally fly 2v4s, start BVR but not count any shots as 'kills' until the merge. Everyone wanted to do a little turning and burning, but the turning became more difficult for the Sea Harrier the higher the altitude.

When Phantoms were present in the British detachment, they occasionally flew Mixed Force Fighter Operations (MFFO,) two Phantoms and two Sea Harriers as a team against two Eagles. In these scenarios, the Phantoms and Eagles would play the BVR game, and the Phantoms would attempt, through a variety of means, to get a Sea Harrier to the merge untargeted. This depended largely on the Phantoms' radar missile evasive manoeuvres. If done too early, the Eagles would simply break lock and re-target the inevitably trailing Sea Harriers.

In my experiences at Deci, the FRS.1s needed a radar missile shooter to follow into the fight just to survive in a BVR environment. In our training scenarios when pre-merge missile shots were disallowed, the Sea Harrier pilots were still battling a huge situational awareness gap despite help from GCI. However, the small size and good overwater camouflage meant that once a turning fight developed, they had good chances of entering it undetected.

The problem was getting there and causing a turning fight to develop. If the Eagles only wanted to 'win' these exercises, there would be no turning fight – but that was also no fun. Getting into a furball, while tactically unsound, allowed everyone to practise other important skills.

Although I never flew against the FA.2 variant, I must believe that the newer pulse-doppler radar and AIM-120s changed the Sea Harrier's prospects as a fighter quite dramatically.

Sea Harrier FRS.1s often flew in company with RAF F-4 Phantoms in Mixed Force Fighter Operations exercises against the F-15s. **Editor's collection**

BT
BT
AF 79 058

Two F-15s of the 36 Tactical Fighter Wing. The far aircraft is from the 53rd Tactical Fighter Squadron based at Bitburg in Germany. **US Air Force**

The Sea Harrier FA.2 with its Blue Vixen radar and the AIM-120 ASRAAM missile made the Harrier a capable fighter and was the last of the 'small wing' variants. **Joe Walsh**

BIG WINGS

The next time I crossed paths with Harriers, I was an instructor at the Tactical Leadership Programme in Florennes when the first detachment of GR.5s joined a course.

I didn't get a flight, but I did crawl around inside one. My first impression was that cockpit ergonomics had been significantly improved. As it turned out, I never saw a small-wing Harrier again.

Eagles and Harriers – chalk and cheese.

I feel very fortunate that my European flying experiences permitted me to have had these glimpses into the operations of a unique aircraft. ■ *Words: Robert I 'Scout' Winebrenner*

Battle Diary 1

A long way from home – the RAF Harrier GR.3s in the Falklands Campaign

The Argentine invasion of the Falkland Islands on April 2, 1982, led to Britain's largest military deployment for 30 years being sent 8000 miles south to get the islands back. Among the forces sent were the British Aerospace Harrier GR.3s of 1 Squadron, under the command of the popular and redoubtable Wg Cdr Peter Squire AFC who was later to become Air Chief Marshal Sir Peter Squire, Chief of the Air Staff.

The Falklands Conflict (April 2 to June 14, 1982), was a unique period in the history of Britain and Argentina. Although war was never formally declared, the brief conflict saw nearly 1000 lives lost and many more people wounded.

The Falkland Islands, which number some 700, lie around 300 miles off the coast of Argentina, and approximately 8000 miles from Britain. In 1982 the population was just over 1800.

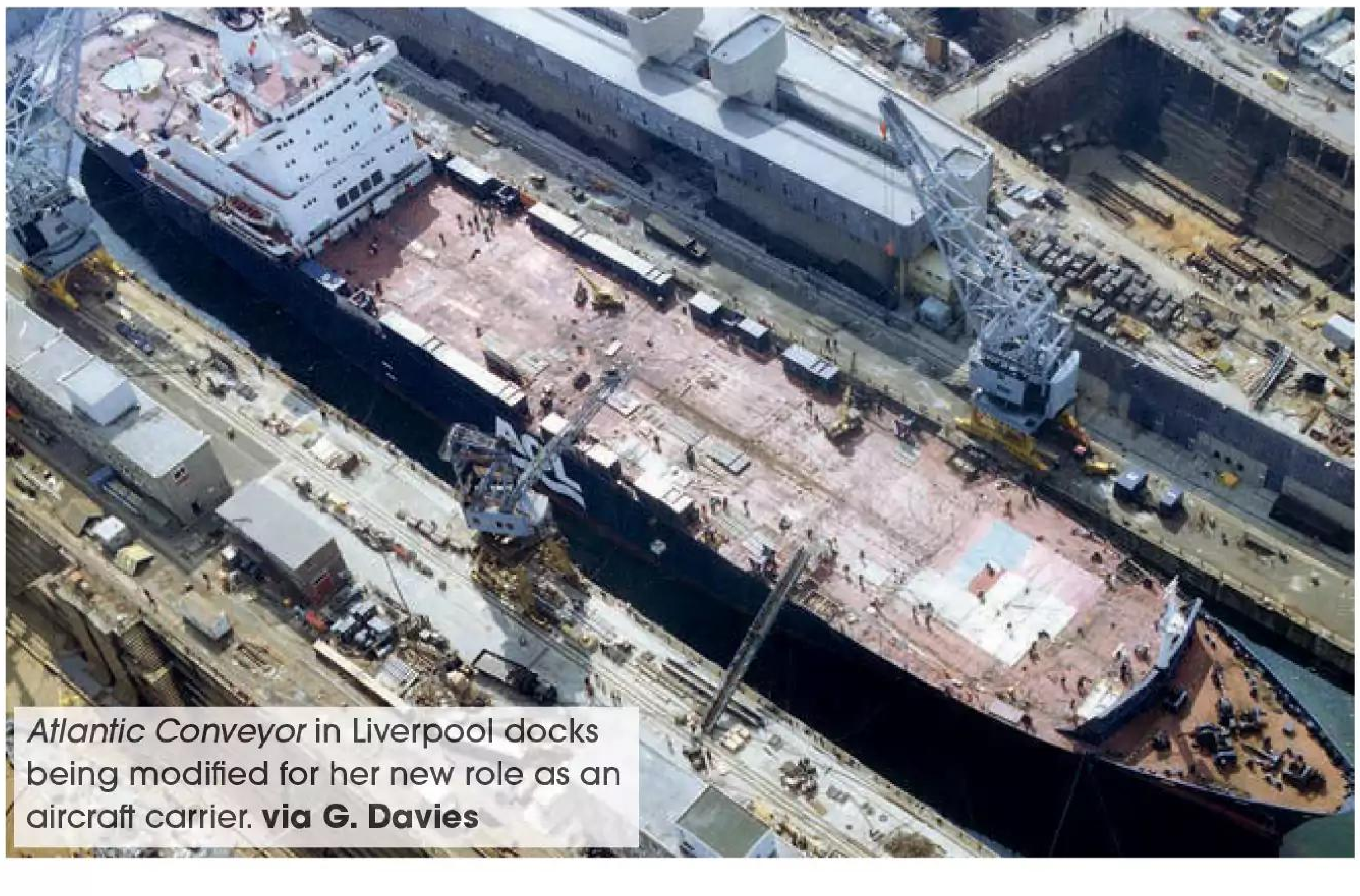
In order to retake the islands, the Royal Navy assembled a Task Force of military vessels of all types. At the centre of this force were two aircraft carriers, HMS *Hermes* and HMS *Invincible*, and two amphibious landing ships, HMS *Intrepid* and HMS *Fearless*. Civilian ships of all types were pressed into service as troop transports, support and supply vessels and in the case of the container ship MV *Atlantic Conveyor*, a temporary aircraft carrier, carrying vital aircraft and helicopters as well as thousands of tons of support equipment intended for the troops ashore once the landings had begun.

Many political initiatives were tried to resolve the situation to no avail. Then, on April 30, 1982, only 28 days after the invasion, the aircraft carriers and escort ships of the British Task Force entered the 200-mile exclusion zone established around the islands.

On board the carriers were the Royal Navy Sea Harriers of 800, 801, and 899 Naval Air Squadrons. These were to fly the first air patrol, ground-attack and reconnaissance missions and the exploits of the squadrons are covered in another article. It must be borne in mind that it was far from clear in the planning stages what aircraft would be able, or required, to do in the South Atlantic. Ground support operations were not seriously envisaged by the Royal Navy or by the RAF until early May, though as early as late April, Admiral Sandy Woodward was indicating that Sea Harriers might be needed for reconnaissance and air support during the landing operations.

The essential task of the Sea Harriers would be to defend Task Force 317, and the small numbers of Harriers in relation to the size of the Argentine air forces suggested the force would have its work cut out. Losses could well be heavy, so the RN and RAF reinforcements that were organised were initially intended as replacements in the same fighter role. 809 NAS was re-formed and the eight Sea Harriers of that unit were sent south to join the Task Force, joined by the Harrier GR.3s of 1 Squadron.

A Harrier GR.3 of 1 Squadron practices ski jump take offs before departing to Ascension Island. **BAE SYSTEMS**



Atlantic Conveyor in Liverpool docks being modified for her new role as an aircraft carrier. **via G. Davies**

Below is a timeline of the activities of 1 Squadron, in the form of a diary, that shows just how flexible and innovative the air and ground crews of the Harriers of both services were in meeting the requirements of Task Force 317, operating at the sharp end of a very long and dangerously thin supply line.

APRIL 8

MoD makes enquiries to the RAF about the possibilities and requirements of deploying 1 Squadron to the South Atlantic. The Assistant Chief of Air Staff (Operations), Air Vice Marshall Ken Hayr, the first commander of 1 Squadron on the Harrier and a man who knows the aircraft well, consults with the station commander and OC 1 Squadron. The recommendations include Dissimilar Air Combat Training (DACT), very low flying training, operational weapons training and the addition of the Sidewinder missile to the GR.3s arsenal.

APRIL 10

The container ship *Atlantic Conveyor* is in Liverpool Docks. Sqn Ldr Bob Iveson (a 1 Squadron Flight Commander) and Sqn Ldr Bruce Sobey (the senior engineering officer) assess the ship for use by Harriers.

The 1 Squadron pilots who went south on board *Atlantic Conveyor*. From left to right, Sqn Ldr Peter Harris, Flt Lt Jeff Glover, Flt Lt Mark Hare, Flt Lt John Rochfort, Sqn Ldr Jerry Pook, Wg Cdr Peter Squire (Officer Commanding), Sqn Ldr Bob Iveson, and Flt Lt Tony Harper sitting. **BAE SYSTEMS**

APRIL 13

The deck of *Atlantic Conveyor* can be used as a platform for both Harriers and helicopters. Furthermore, the car decks can also be loaded with enormous quantities of stores.

APRIL 15

Clearance for the GR.3 to use the ski-jump is received and the first three pilots deploy to Yeovilton to carry out training.

APRIL 16

Ski-jump training continues at RNAS Yeovilton. RAF Wittering is ordered to deploy up to 12 aircraft on or about April 26. The modification programme for the aircraft starts in earnest to provide deck capability. Modifications include an I-Band transponder (for IMC recoveries), undercarriage shackles, active nose wheel steering, hardened limiters for the JPTL system and anti-corrosion treatment. The Sidewinder is still being considered.

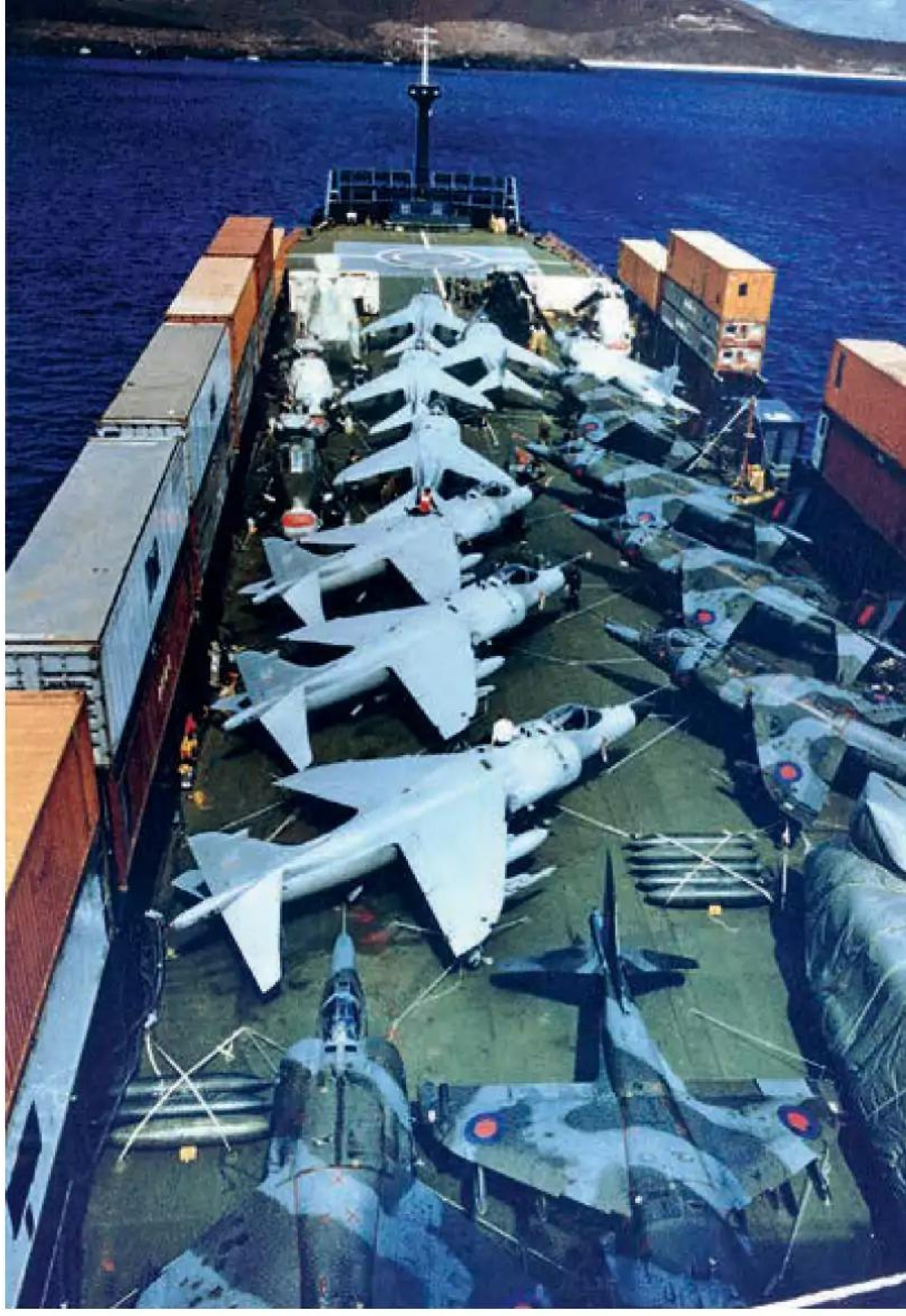
APRIL 18

The deployment of 1 (F) Squadron, first to Ascension Island and subsequently to the Falkland Islands, is confirmed.

APRIL 19

The initial deployment plan is that nine aircraft will deploy to Ascension Island between April 26 and 28. Six will join the Task Force and three will remain at Ascension Island for air defence duties. Eighteen engineers will provide GR.3 support, split between both carriers, and the remainder of the squadron would follow for subsequent operations from ashore. The pilots who go south are: Wg Cdr Peter Squire, Sqn Ldr Jerry Pook, Sqn Ldr Bob Iveson, Flt Lt Tony Harper, Flt Lt John Rochfort, Flt Lt Mark Hare, Flt Lt Jeff Glover and Sqn Ldr Peter 'Bomber' Harris.

A Harrier GR.3 lands aboard *Atlantic Conveyor* for the first time. **BAE SYSTEMS**



The scene on *Atlantic Conveyor's* deck before a herculean effort by the ground crew. **BAE SYSTEMS**

APRIL 20

1 Squadron carries out live CBU drops against a splash target off the east coast.

APRIL 21

Briefings commence on the concept of an amphibious assault followed by the building of a Harrier site ashore.

APRIL 23

1 Squadron flies DACT sorties with Mirage and Etendard aircraft of the French Armed Forces. Following the successful design of an AIM-9 modification, missiles are allocated to 1 Squadron for practice firings at Aberporth. The Sidewinders are cleared for use.

APRIL 24

Deployment date delayed until at least May 1. The RAF Wittering Engineering Wing is working round the clock to modify an initial batch of 12 aircraft in order to get nine to Ascension Island.

APRIL 26

Approval is given to carry out operational low flying. 1 Squadron practices firing rockets and is cleared to carry and fire the RN's 2- inch rocket of which 36 are carried in each pod. A trial sortie with the rockets is flown at Yeovilton.

APRIL 27

Modifications continue. The Ferranti Inertial Navigation Reference and Attitude Equipment that allows the Inertial Navigation and Attack System to align while on a moving platform is tested.

APRIL 30

Six aircraft deploy to RAF Valley to carry out live AIM-9G Sidewinder firings on ➤

A Harrier GR.3 departs *Atlantic Conveyor* for the last time. **BAE SYSTEMS**

Aberporth range. Of the six firings only one missile fails.

MAY 2
The first five aircraft deploy to St Mawgan.

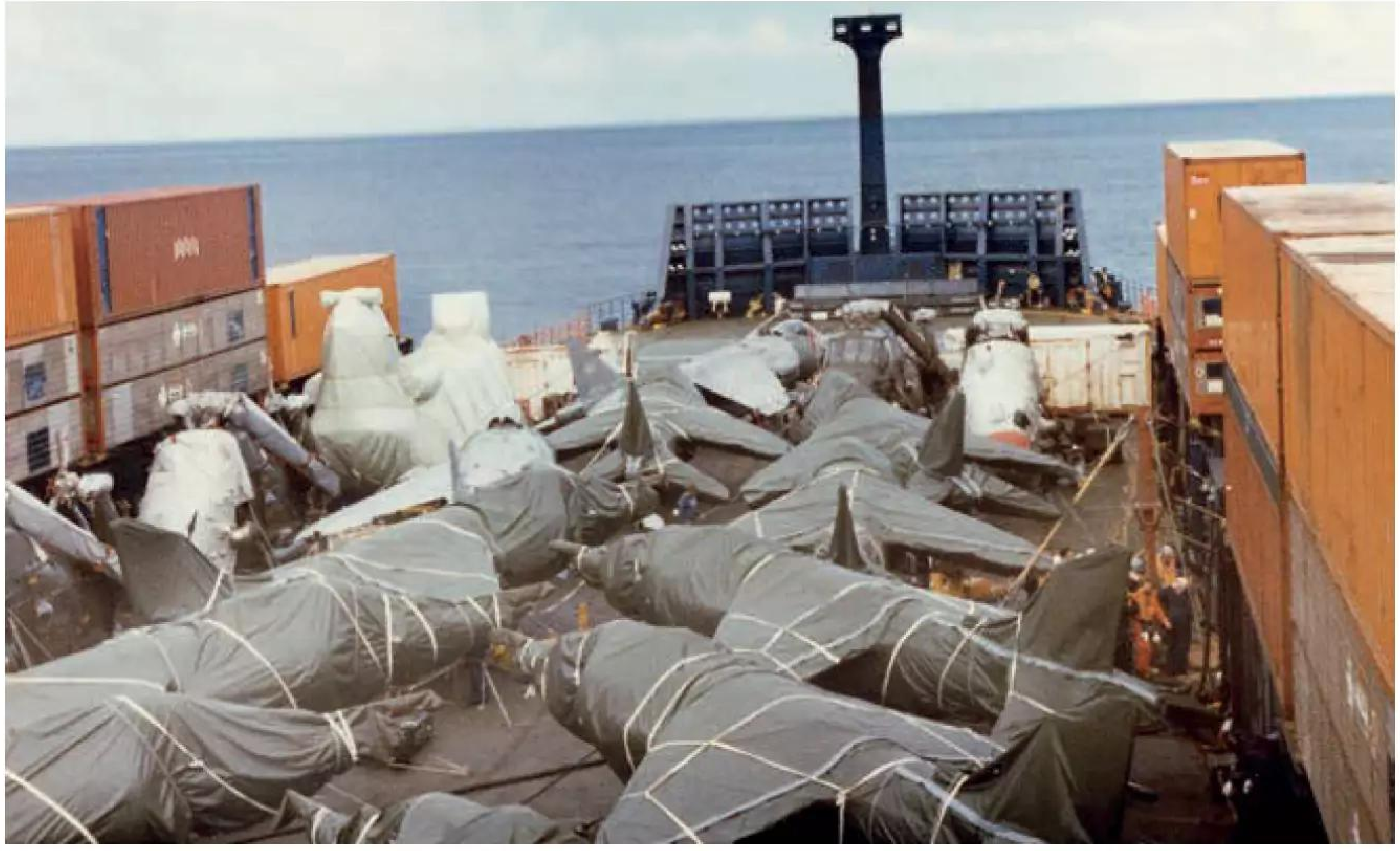
MAY 3
The first three Harrier GR.3s arrive at Ascension Island. One, flown by Squire, had to divert to Banjul due to a problem with one of the Victor tankers. After refuelling on the ground, the tanker and Harrier proceed to Ascension.

MAY 4
Another two Harrier GR.3s arrive at Ascension, with one diversion, this time to Porto Santo.

The first landing by a 1 Squadron Harrier GR.3 on board HMS *Hermes*. **BAE SYSTEMS**

May 20, 1982, 1 Squadron is ready to fly its first operational mission of the Falklands War, against the POL site at Fox Bay. **BAE SYSTEMS**

A Harrier GR.3 departs HMS *Hermes*. **BAE SYSTEMS**



Aboard the *Conveyor*, with all the aircraft safely bagged against the weather. **BAE SYSTEMS**

MAY 5
Two more Harrier GR.3s arrive at Ascension, again with one diversion, this time to Banjul.

MAY 6
Six Harrier GR.3s embark aboard the *Atlantic Conveyor* and stores are loaded all day. The Harrier that diverted to Banjul the previous day arrives at Ascension, flown by Flt Lt Ross Boyens.

MAY 7
Loading of squadron stores aboard *Atlantic Conveyor* continues.

MAY 8
The aircraft begin to be sealed in protective bags on board *Atlantic Conveyor* through herculean efforts by the ground crew. The FINRAE equipment is not working, which is more work for the ground team. *Atlantic Conveyor* departs Ascension Island.

MAY 9
Bagging of 1 Squadron GR.3s and 809 NAS Sea Harrier FRS.1s (known as a SHAR) continues. The FINRAE problem is traced to wiring faults.

MAY 10
Aircrew from 1 and 809 Squadrons conduct joint ground training. An 809 SHAR is brought to Readiness State 5 (RS5) for a possible interception of the shadowing Argentine Boeing 707.

MAY 11
The SHAR at RS5 is scrambled but the launch is cancelled.

MAY 12
The *Atlantic Conveyor* carries out a Replenishment at Sea (RAS) with RFA Tidepool.

MAY 13
The 70th Anniversary of the formation of 1 and 3 Squadrons is celebrated and team photographs are taken. Two of the 809 NAS pilots are on detachment from 3 Squadron.

MAY 14
FINRAE software modification details arrive by SATCOM and work begins to modify it. All the aircraft are bagged so trials cannot be carried out.

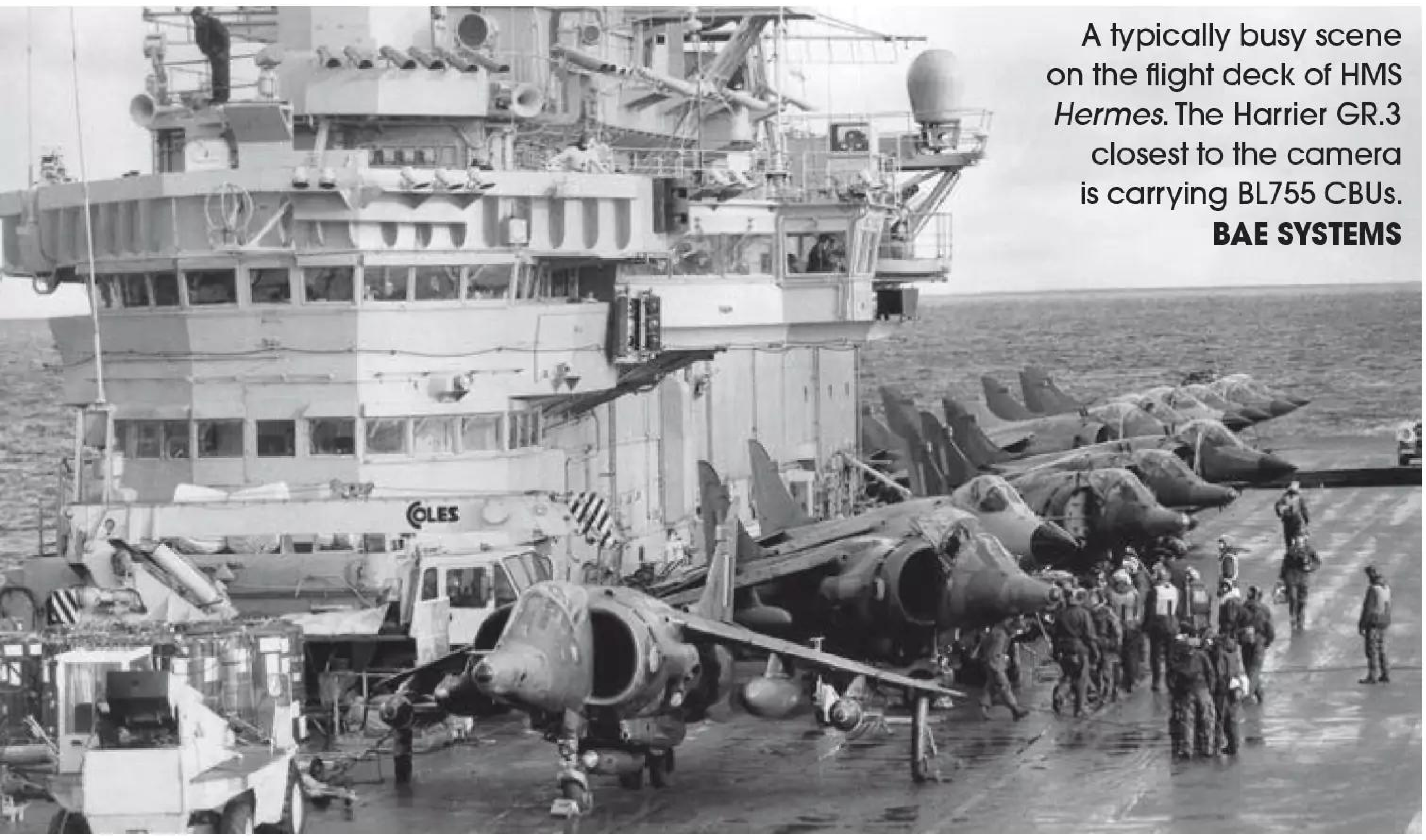
MAY 15
Back in the UK, the trial on the active I-Band jammer (to counter the Argentine Fledermaus radar) starts and the ALE-40 chaff and flare dispenser modification programme begins.

MAY 16
Atlantic Conveyor joins the Landing Ship Logistic (LSL) Group which includes the two Landing Platform Docks (HMS *Intrepid* and HMS *Fearless*), two Type 42 Destroyers and two Type 21 Frigates, making a force of 21 ships.

MAY 17
The weather improves so the unbagged aircraft move to HMS *Hermes*. Initial FINRAE trials are carried out and appear to work.

MAY 18
HMS *Hermes* and *Invincible* close with the amphibious group in order to effect the aircraft transfer well out of range the enemy. Only four GR.3s transfer as two are unserviceable. Squire, Pook, Rochfort, and Harris make an uneventful crossing. Ground crew, pilots and stores are cross decked to HMS *Hermes*.

MAY 19
Fifteen Air Combat Training sorties are flown armed with AIM-9 Sidewinder missiles. On the first one, Squire and Flt Lt Geoff Glover are vectored on to the shadowing Boeing 707. Nothing is found. The fifth GR.3 arrives from *Atlantic Conveyor*, flown by Harper. FINRAE has not yet arrived so the aircraft are being flown without navigation aids. Since the SHAR force is not to be preserved to protect the fleet, the GR.3s are to be used only on attack missions, not air defence. Night landing


A typically busy scene on the flight deck of HMS *Hermes*. The Harrier GR.3 closest to the camera is carrying BL755 CBUs. **BAE SYSTEMS**

practices are carried out after sunset. Squire is briefed by the captain of HMS *Hermes*, Lin Middleton, that 1 Squadron will fly its first operational mission the next day against the Petrol, Oil, Lubricants (POL) storage area at Fox Bay, West Falkland.

MAY 20

The sixth GR.3 arrives from *Atlantic Conveyor* flown by Rochfort. Squire, Pook and Iveson take off at 1400 armed with three Cluster Bomb Units (CBUs) each. Iveson reports that there are large secondary explosions from the leader's weapons. No groundfire is encountered and the three aircraft returned to HMS *Hermes*.

MAY 21

Operation SUTTON, the invasion by the British to retake the Falkland Islands, begins at dawn. Pook and Hare fly an armed reconnaissance mission to find Argentinean helicopters at a forward operating base (FOB) near Mount Kent. Two Pumas and a Chinook are found and attacked, all three helicopters catch fire. Squire and Glover take off on a Close Air Support Combat Air Patrol (CAS CAP) but the undercarriage on Wg Cdr Squire's aircraft will not retract, so he is forced to land back on HMS *Hermes*. Jeff Glover carries on alone, and is shot down near Port Howard, becoming a Prisoner of War (POW). Harris and Rochfort fly a CAS CAP and reconnoitre from Cape Dolphin to Bombilla Hill to Brodie Peak. Lastly, Harper and Pook fly an armed reconnaissance of the airstrip at Dunnose Head and take photographs, but find no enemy activity.

MAY 22

Operation SUTTON continues with no requirement for CAS missions. Pook, Iveson, Rochfort and Harris make an attack on the airfield at Goose Green and positions around it. Considerable anti-aircraft fire is experienced but all four aircraft return safely. Squire and Harper fly an armed reconnaissance to the airstrip on Weddel Island but nothing is seen.

MAY 23

At 1320 Harris, Hare, Squire and Harper make an attack on the Dunnose Head airstrip, thought to be a FOB for Pucara ground-attack aircraft. Four CBUs and six 1000lb retarded bombs are dropped. Pook and Rochfort fly an armed reconnaissance of Port Howard and lastly, Squire, Pook and Rochfort attack the Pebble Island airstrip with six CBUs, then make a reconnaissance of Chartres airstrip. 800 NAS loses an aircraft on take-off on a night mission to attack Port Stanley airfield.

MAY 24

Flying in co-operation with two 800 NAS Sea Harriers which fly defence suppression missions, Iveson, Harper, Squire and Hare drop a dozen 1000lb retarded bombs on the runway at Port Stanley. All the aircraft return safely, although the Sea Harriers are locked up by Fledermaus and Roland anti-aircraft systems. Due to bomb debris damage to one GR.3, future bombing is ordered to be made at high angles.

MAY 25

Pook, Harris, Squire and Rochfort fly in 'loose V formation' with two 800 NAS Sea Harriers and attacked Port Stanley's airfield runway with a dozen 1000lb bombs fitted with various delay fuses. Sqn Ldr Pook pulls up after releasing his weapons to observe the attack. At altitude, he watches a Roland missile fired at him fall short some distance below, while a Tiger Cat missile launched against the second wave also falls short. Later, Harris and Hare attack the runway again, with six 1000lb bombs dropped from level flight at 20,000ft. Only three are seen to explode, and these fall in Yorke Bay. Again, Roland missile and AAA fire is seen to fall short. Harris goes back a third time at 1925 with another three 1000lb bombs, which he releases in a 30-degree loft attack, but all fall short of Port Stanley's runway. FINRAE is still not working, so the inertial navigation system and weapons aiming computer are useless. The attacks are to prevent Super Etendard attack aircraft recovering to Port Stanley using the arrestor gear on the runway. A dusk attack on the Task Force by Argentinean aircraft succeeds in sinking HMS *Coventry* and the *Atlantic Conveyor*. Sadly, Captain North, a friend to the squadron while it was aboard, is killed. Along with the ship, many supplies for the Harriers, such as 200 CBUs, are lost. Fortunately, all 1 Squadron personnel had already moved to HMS *Hermes*.

Harrier GR.3 in the hover with AIM-9 Sidewinders fitted in its secondary role of fighter. **BAE SYSTEMS**

The LGB, as fitted to this Harrier GR.3, was only successfully used twice in the whole campaign. **BAE SYSTEMS**

MAY 26

Iveson and Harper attack enemy positions around Port Howard, hitting tents and vehicles and dropping four CBUs. Pook and Rochfort fly an armed reconnaissance of the 10km area looking for enemy artillery but find nothing. Squire flies a solo mission to bomb the runway at Port Stanley with three 1000lb bombs, the fall of which is not observed. Lastly, Pook and Hare fly an armed reconnaissance from Teal Inlet settlement to Port Stanley. Near Mount Kent, a Puma helicopter is seen, close to where the others were destroyed. A CBU is dropped on the Puma and secondary explosions seen. Despite a great deal of AAA fire as well as a shoulder launched anti-aircraft missile, both aircraft return safely, Pook with a single hole in his drop tank.

MAY 27

2 Para commences its attack on Darwin and Goose Green. At sea there is fog and no flying is possible before 1400Z (1000 local time). Harris and Harper fly to attack ➤

the runway at Port Stanley with six 1000lb bombs, three of which hit the airfield and three land in the water to the south. Iveson and Hare launch at 1400 on a CAS mission to support the assault on Goose Green. Four CBUs are dropped on troops and defensive positions. Squire and Rochfort follow with a second CAS mission, but the forward air controller (FAC) cannot be contacted which means the aircraft have to stay high to get details from the ASOC. Both aircraft are illuminated and tracked by AAA radars. No weapons are dropped. Iveson and Hare return to Goose Green at 1600 with four CBUs. Three attacks are made on troop positions, a 105mm artillery gun and a company position with CBUs and strafing, despite the high levels of AAA fire from the area. On the last pass, Bob Iveson's aircraft is hit and begins to burn. He flies to the west of the target and ejects. Pook flies a reconnaissance of Port Stanley and Goose Green at 18,000 and 15,000ft, but sees no sign of Bob Iveson or his aircraft.

MAY 28

The bad weather continues to keep the Harriers on the deck. The first mission to Goose Green at 1330 is almost scrubbed due to the weather, but Squire, Harper and Harris make an attack with four 2-inch rocket projectile pods. Flt Lt Harper is unable to release his weapons due to the weather. Harris, Harper and Pook return to Goose Green at 1905 when an ASAP CAS call is received to support the 2 Para assault on the settlement. Two 2-inch rocket pods and four CBUs are used with great accuracy against an FAC specified target. After the attack the three make a reconnaissance run over the area where Bob Iveson ejected, but nothing is seen.

MAY 29

Goose Green surrenders and over 1000 prisoners are taken. 2 Para picks up Iveson, who is safe. On the only sortie of the day, Squire and Hare fly an attack on an Argentine OP and defensive positions on Mount Kent, hitting the targets with four 2-inch rocket pods and strafing runs.

MAY 30

Five sorties are flown in showery weather. On the first, Pook and Harper attack possible radar sites on Mount Round and Mount Low with six 1000lb retarded bombs but no targets are positively identified. Next, Squire and Hare attack targets identified by a Special Forces FAC on the north slopes of Mount Kent with four 2-inch rocket pods. A new weapon is tried to solve the bombing accuracy problem caused by the non-functioning navigation system. Harris and Harper take one 1000lb bomb and one laser guided bomb (LGB) up to 35,000 feet and enter a 60-degree dive. The trailing aircraft follows, attempting to illuminate the target with its nose mounted LRMTS. The results are inconclusive as no bomb impacts are observed. Pook and Rochfort launch at 1435 to attack artillery on Mount Wall, but en route are re-tasked to attack helicopters on the ground. No targets are seen at the new location, but the original artillery target is clearly visible and the two aircraft attack with 2-inch rocket pods. Pook's aircraft is hit in the attacks, and on the way back is losing fuel and experiencing hydraulic failure. Some 30 miles from HMS *Hermes*, he ejects and is swiftly rescued by the SAR helicopter from the carrier. The last mission of the day is flown by Squire and Hare with 2-inch rocket pods.

Sea fog prevented air operations for several days of the campaign. **BAE SYSTEMS**

MAY 31

Two aircraft are on call for CAS when a report is received of swept wing aircraft, possibly Etendards, at Port Stanley airfield. The aircraft, flown by Squire and Hare, are tasked to attack the aircraft with 2-inch rocket pods in co-operation with Sea Harriers with 1000lb bombs. Postwar reconnaissance shows these to be straight wing Aermacchi ground-attack aircraft. A great deal of small arms fire is seen in the attack, both aircraft are hit and each windscreen cracked, plus Squire's drop tanks are holed. Harris and Rochfort try LGB designation again against Port Stanley airfield then make a photo reconnaissance from Mount Low to Long Island.

JUNE 1

Only one GR.3 is now serviceable. Squire flies a reconnaissance from Bluff Cove to Goose Green accompanied by Flt Lt Ted Ball attached to 800 NAS in a Sea Harrier. Enemy positions are identified near Fitzroy Bridge. Flt Lt Ian Mortimer attached to 801 NAS is shot down over Port Stanley by a Roland missile. He ejects and is rescued by an SAR helicopter after several hours in a dinghy. Two more Harriers arrive from Ascension flown by Flt Lt Mike Beech and Flt Lt Murdo McLeod, having refuelled from four Victor tankers en route. As a safety measure, HMS *Engadine* is positioned halfway between Ascension and the Task Force as a diversion.

JUNE 2

Sea fog and bad weather generally limit all flying and the next reinforcement package from Ascension is postponed.

JUNE 3

Foul weather prevents flying. As well as the aircraft and aircrew reinforcements more groundcrew have arrived at San Carlos.

JUNE 4

Sea fog again prevents flying.

JUNE 5

Sea fog prevents flying until the afternoon. Iveson and Harper fly to the San Carlos FOB and base there for several days. Pook and Hare fly a low level photo reconnaissance sortie from Bluff Cove to Hooker Point and Squire and Beech fly an armed reconnaissance of Pebble and Keppel Islands, Rat Castle Shanty, Dunnose Head and Spring Point Hill. Two Pucaras are seen at Pebble Island and these are attacked with 2-inch rocket pods and strafed.

JUNE 6

Again in poor weather, Squire and Beech fly an armed photo reconnaissance sortie to Hooker Point looking for the land launched Exocet that had hit HMS *Glamorgan* two days earlier. Squire drops two CBUs on defensive positions south of Port Stanley.

XZ989 after its partial engine failure that gave Wg Cdr Peter Squire a rough time at the San Carlos FOB. **BAE SYSTEMS**

Close up of an LGB on a Harrier GR.3. **BAE SYSTEMS**

JUNE 7

Pook and Rochfort attack 155mm artillery positions near Sapper Hill with four 2-inch rocket pods. The FOB strip at San Carlos causes considerable damage to tyres. From now on aircraft deploy as required to sit on ground alert. The SHARs make far greater use of the FOB, it more than doubles their available time on CAP.

JUNE 8

Squire and Hare deploy to the San Carlos FOB to take over Ground Alert. Squire is flying XZ989 which has a number of defects. On take-off full emergency power beyond the limiter is required. On arrival at the FOB Squire overshoots as he believes he has lifted metal on the pad and wants to see what damage has been done. The engine does not respond. He elects not to eject and the aircraft hits the ground hard and slides to a stop. Once the strip is cleared, Hare lands, refuels and returns to HMS *Hermes*. Flt Lt Ross Boyens and Flt Lt Nick Gilchrist arrive from Ascension Island with two new aircraft. The four new GR.3s delivered have the modified ALE-40 chaff and flare dispenser and active I-band jammer and one of them can fire the Shrike anti-radiation missile.

JUNE 9

Starting from the FOB, Squire and Boyens fly an attack on artillery positions on Mount Langdon using 2-inch rocket pods. At 1340, Harris and McLeod conduct a similar mission against a 155mm artillery position next to Sapper Hill. Murdo McLeod is hit by shrapnel which causes a hydraulic failure on landing.

JUNE 10

Four pairs sorties are flown in good weather. Squire and Hare drop CBUs on enemy positions on Mount Tumbledown and Mount Langdon. Photo reconnaissance is flown during the strike revealing the presence of Blowpipe and SAM 7 shoulder launched surface to air missiles. Harris and McLeod are tasked to provide CAS to Special Forces near Port Howard. No contact with the FAC is made so an armed reconnaissance is carried out.

Harper and Rochfort were to fly another trial with the LGBs, but the FAC is not in position so the weapons are jettisoned on return to the carrier. Squire and McLeod fly the last sortie of the day to attack the troop positions identified south of Moody Brook Road on the first mission of the day. Four CBUs are dropped and secondary explosions seen. Mcleod had his windscreen cracked by the high density of small arms fire encountered.

The Harriers are manned and ready waiting to depart HMS *Hermes* for the last time, moving to Port Stanley airfield, soon to be renamed RAF Stanley. **BAE SYSTEMS**

JUNE 11

Five sorties are flown to soften up the defensive positions around Port Stanley. Harper and Gilchrist fly an LGB sortie to strike targets near Mount Tumbledown. The FAC's laser target marker (LTM) is unserviceable so the weapons are delivered 'by hand'. Boyens and Rochfort use CBUs and strafing runs against enemy positions on Two Sisters Mountain. The ALE-40 proves effective against AAA radar on this mission. Pook and Beech drop four CBUs on artillery and mortar positions on Mount Harriet, and Harris and Gilchrist drop four CBUs on troop and gun positions on Mount Langdon. The last sortie sees Squire and Hare attack a headquarters and artillery position on the eastern slope of Mount Tumbledown with four 1000lb bombs. The retard tails fail to deploy and the bombs do not arm. Squire's aircraft is hit by small arms fire which holes the cockpit. Both aircraft are attacked by SAMs which are successfully evaded.

JUNE 12

Three CAS sorties are flown. Boyens and Beech drop four CBUs on gun positions on Sapper Hill. Harper and Gilchrist fly an armed reconnaissance and attack troops in the open east of Mount Harriet with four CBUs and strafing runs. Harris and McLeod drop four CBUs on a 155mm artillery position on Sapper Hill. During this, Murdo McLeod is hit by shrapnel, damaging his reaction control jet line in the rear equipment bay. On hovering to land, this starts a fire which is extinguished by the ground crew after a quick and professional landing. The push towards Stanley begins. The first day's objectives of Mounts Langdon, Two Sisters and Harriet are taken.

JUNE 13

Two successful LGB sorties are flown with FACs equipped with LTMs in support of the push on Port Stanley. Squire and Hare fly the first, Squire dropping two LGBs and scoring a direct hit on an enemy position. The second is flown by Pook and Beech, again, dropping two LGBs on a target near Mount Tumbledown and scoring a direct hit.

JUNE 14

Harris and Gilchrist fly the only sortie with LGBs and CBUs against targets near Sapper Hill, but it is cancelled after the aircraft are in the hold as a cease fire is called.

JUNE 15

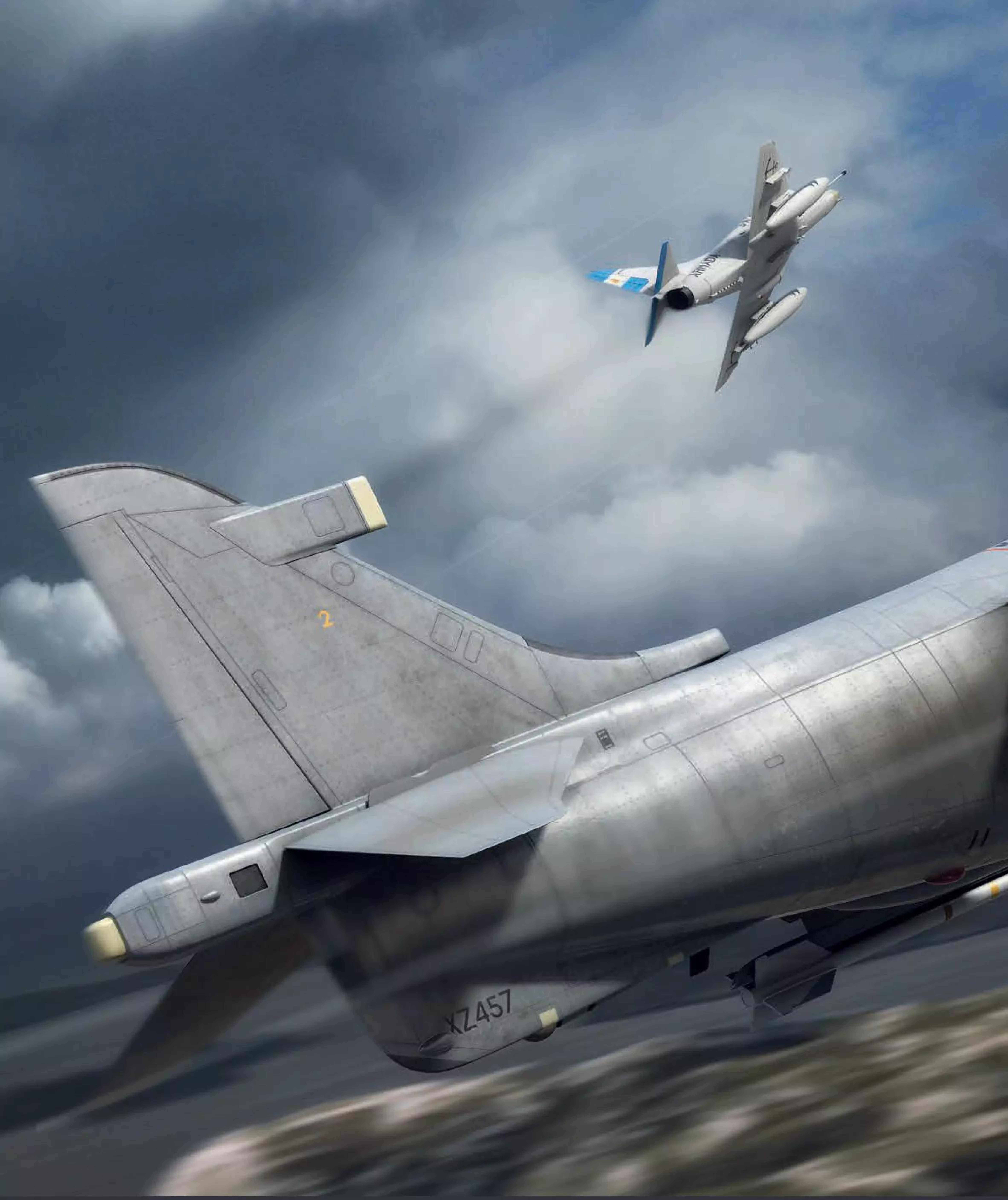
Argentinean forces in the Falkland Islands surrendered unconditionally. Gale force winds and tempestuous seas mean no flying anyway.

On July 4, the Harrier GR.3s of 1 Squadron moved to Port Stanley airfield in the driving snow. The tented accommodation was to be the home of the Harrier in the Falklands for some time until the new airfield at Mount Pleasant was built.

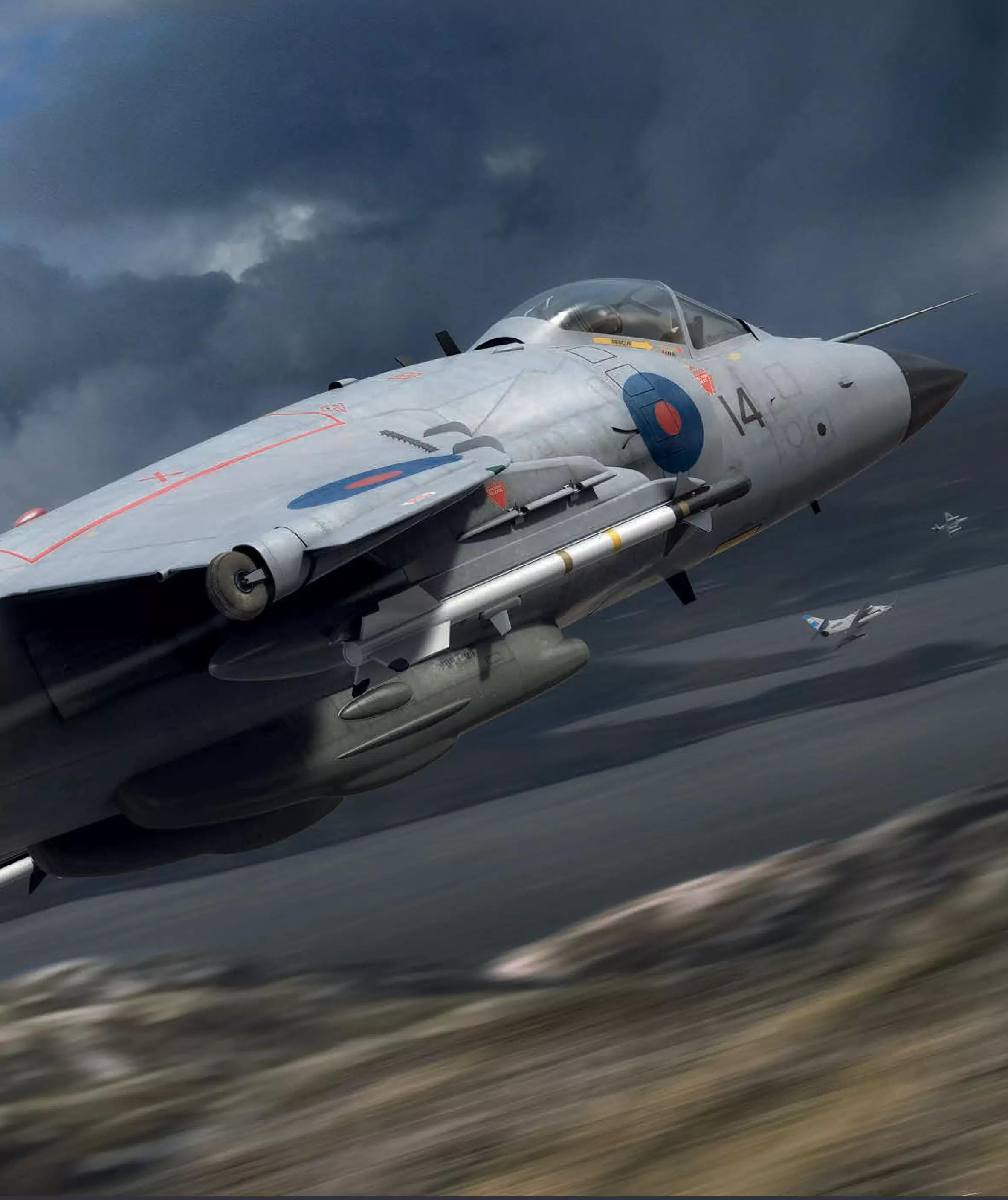
The Harriers remained at RS10 in case of Argentinean reprisal raids, but these never materialised. The Harrier's first full blown war was over, and considering the conditions under which the aircraft operated, it had been an amazing success. ■

Words: Tim Callaway

On arrival over the new home, the Harriers let everyone know which squadron was taking up residence in fine style. **BAE SYSTEMS**



FLEEING HAWKS



Sea Harrier FRS.1 ✦ No 899 Naval Air Squadron ✦ Falklands Task Force 1982

Over the Falklands

Sea Harriers vs Argentine Mirages and Daggers

"Hokey religions and ancient weapons are no match for a good blaster at your side, kid." Han Solo, character in the movie Star Wars, Episode IV: A New Hope, 20th Century Fox, 1977

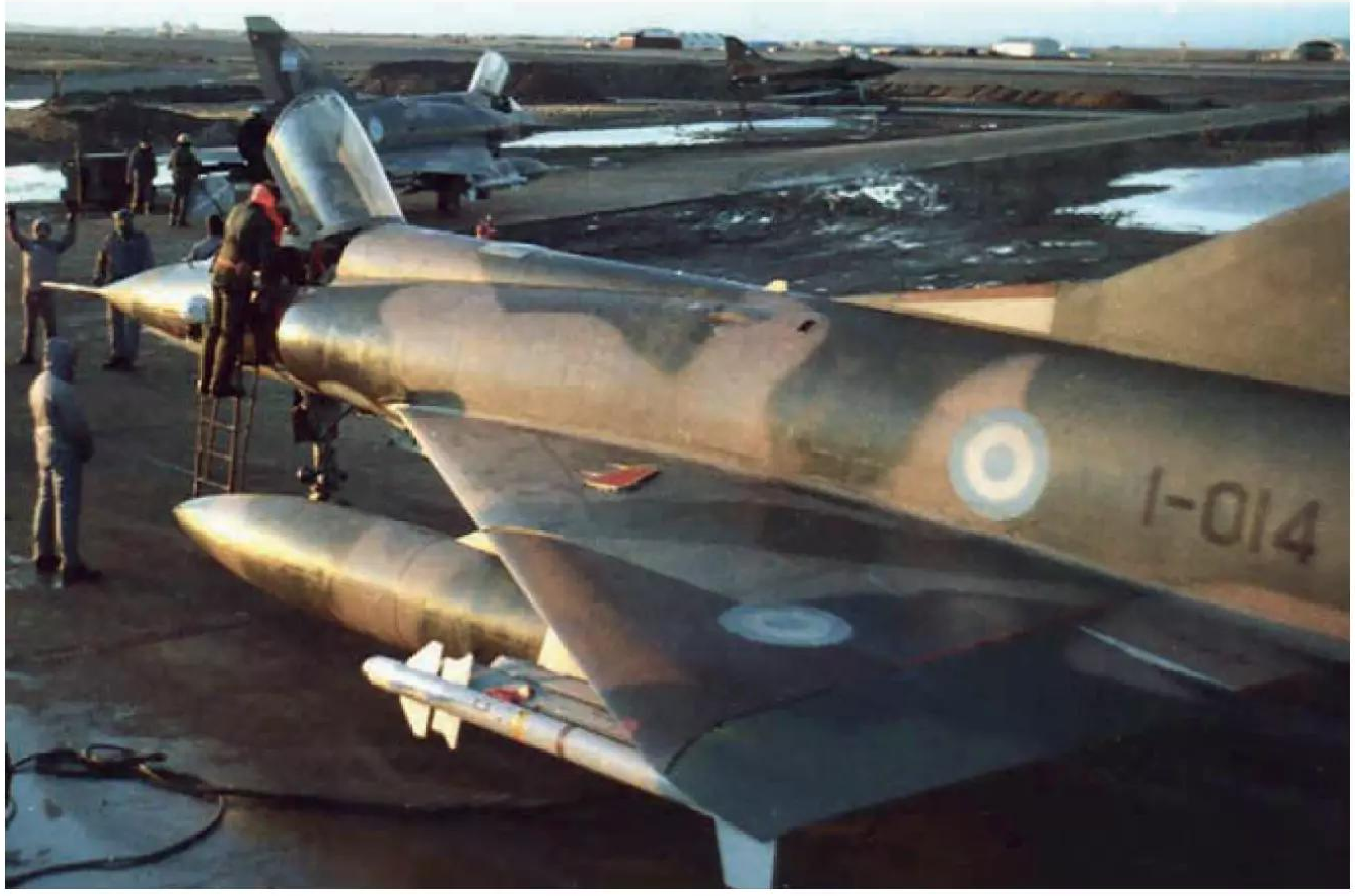
In the case of the 1982 Falklands conflict the 'hokey religion' was el Presidente General Leopoldo Galtieri's misguided belief that he could divert his people's increasing unrest over domestic issues with a desperado-like foreign adventure. The 'ancient weapons' was that he thought he could defend these ill-gotten gains with 1960s air power technologies. The 'blaster' – which proved him wrong on both counts – was the BAE Sea Harrier.

The Falklands' (called the Malvinas in Argentina) single paved airfield, Port Stanley Airport, had insufficient runway (4100ft/1250m) to support modern high-performance jet aircraft, so what air power the Fuerza Aerea Argentina (FAA) could exercise would have to be flown from mainland bases over 400 nautical miles (740km) away. Their combat units included two small fighter-interceptor squadrons equipped with 12 French-built Dassault Mirage IIIEAs, two fighter-bomber squadrons with 26 former-Israeli Neshers (Hebrew for 'Eagle'), three attack squadrons with 38 exUSN Douglas A-4P (refurbished A-4B/Cs) Skyhawks, and a bombardment squadron with nine BAe Canberra B.Mk 62s and combat-capable T.Mk 64s.

The figures listed here are 'operational', that is 'combat ready', for each type. Larger numbers are usually touted by those who want to make a point about how 'badly outnumbered' the Sea Harriers were, but their figures represent total 'iron on the ramp', including non-operational trainer variants and cannibalised 'parts donors'.

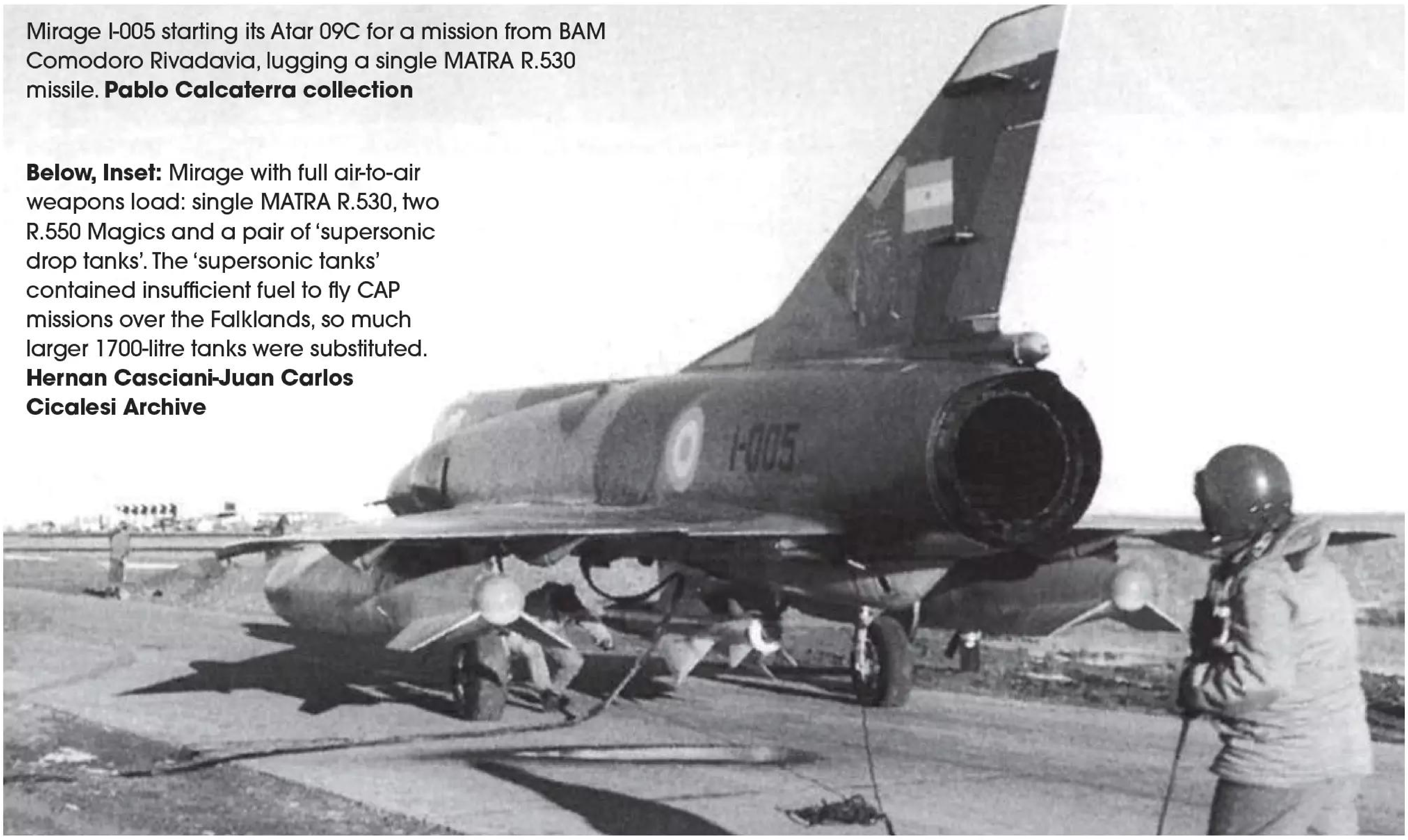
Since the nearest airfield that the British could use – Wideawake airport on Ascension Island – was 3415 nautical miles (6325km) distant, Brigadier General Basilio Lami Dozo and the rest of the FAA leadership could rest easy – at least until the Royal Navy arrived.

That wasn't for very long. Heading south to Ascension was the Royal Navy's Task Force 317 (TF 317) initially consisting of two aircraft carriers, eight destroyers and 10 frigates. During the next four weeks TF 317 would be joined by one destroyer and five frigates, and for the amphibious assault to retake the islands it would be shepherding two large assault ships, six landing ships, 15 Royal Fleet Auxiliaries, four hospital ships and 31 merchant



Unable to base combat jets in the Falklands/Malvinas, the FAA had to fly from mainland air bases such as BAM Rio Gallegos, where Grupo 8 Mirages and Grupo 5 Skyhawks were stationed. Mirage I-014 is armed with the highly manoeuvrable MATRA R.550 'Magic' IR AAM. **Hernan Casciani-Juan Carlos Cicalesi Archive**

Royal Navy aircraft carriers HMS *Hermes* and *Invincible*. **Editor's collection**



Mirage I-005 starting its Atar 09C for a mission from BAM Comodoro Rivadavia, lugging a single MATRA R.530 missile. **Pablo Calcaterra collection**

Below, Inset: Mirage with full air-to-air weapons load: single MATRA R.530, two R.550 Magics and a pair of 'supersonic drop tanks'. The 'supersonic tanks' contained insufficient fuel to fly CAP missions over the Falklands, so much larger 1700-litre tanks were substituted. **Hernan Casciani-Juan Carlos Cicalesi Archive**

vessels pressed into naval service. The four submarines assigned to Operation Corporate formed Task Force 324.

Aboard the two carriers were 20 BAE Sea Harrier FSR.1s (called 'SHARs' for short), representing three Naval Air Squadrons (NAS): Nos. 800 (HMS *Hermes*), 801 (HMS *Invincible*), and 899 (the Sea Harrier 'headquarters and training unit' reinforcing both carriers' air groups). Additionally, *Hermes* embarked nine Westland Sea King ASW helicopters (826 Sqn) and a like number of Sea King transports (846 Sqn) while *Invincible* embarked nine ASW Sea Kings (820 Sqn).

These were supplemented by eight more 'SHARs' (809 NAS), six of which were ferried to Ascension on April 30, and, once joined by the last pair on May 3, were flown aboard the MV *Atlantic Conveyor* three days later.

In traditional terms, in order for the 59 Argentine attack, strike and bomber jets (this figure also includes 12 Comando de Aviación Naval (COAN) attack aircraft – eight Douglas A-4Qs (modernised A-4Bs) and four new Dassault Super Etendards) to get to their targets, it would be up to the 38 Mirages and Daggers to clear the skies of 'SHARs' and thus enable the 'strikers' to do their job.

THE ADVERSARIES COMPARED – THE MIRAGE IIIEA

The FAA originally purchased 17 single-seat Mirages IIIEAs (and a pair of IIIDA twoseaters) – in 1972 and 1979 – these forming two squadrons under VIII Brigada Aerea/Grupo 8 de Caza at BAM (Base Aerea Militar) Mariano Moreno, to defend the capital, Buenos Aires.

The Mirage IIIE was the final iteration of Dassault's delta-winged inspiration, made famous by the Heyl Ha' Avir Israeli Defence Forces/Air Force, IDF /AF) during the 1967 'Six-Day War'. Designed as a supersonic all-weather interceptor it was armed with a pair of 30mm DEFA 552 cannon and a choice of MATRA air-to-air missiles (AAMs). Powered by the 13,668lb thrust SNECMA Atar 09C-3 afterburning turbojet, it could attain Mach 1.13 (863knots/1592kph) at low level and 2.2M (1460kts/2693kph) at high altitudes (39,370ft/12,000m).

However, even at high level the Atar was a prodigious 'gas guzzler', limiting the Mirage's effective combat radius to 450 nautical miles (830km – Port Stanley was 420nm/778km from BAM Rio Gallegos, the nearest FAA base), which gave it a maximum of 12 minutes (at high altitude/five minutes at low level) in the combat arena. Thus for fuel considerations, ingress was necessarily at high altitude, making the Mirages' approach obvious to any surveillance radars.

The Mirage's Thomson-CSF Cyrano II radar was a 200kW I/J-band monopulse system with a 25-mile (45km) range. However, being a pulse radar, it was limited to level and 'look up', with a slight 'depressed angle' capability from higher altitudes over water. Therefore, when entering the combat zone the Mirage pilot's radar could only locate targets at a similar, or higher, altitude.

The Cyrano II supported the MATRA R.530E AAM, which was provided to Argentina in both semi-active radar (SAR) homing and infra-red OR) seeking versions. Although significantly upgraded from its original 1962 form (when its performance closely resembled the USAF's worthless Hughes AIM-4 Falcon), it nonetheless remained a weapon designed to bring down large Tupolev bombers flying straight and level. While its two-stage Hotchkiss-Brandt/SNPE Antoinette rocket motor could boost it to Mach 2.7 and sustain it for approximately 10nm (18km) it was a heavy – 423lb (192kg) – projectile with extremely poor manoeuvrability, making it easily defeated by an agile adversary. While flying air combat training with and against the Armee de l'Air Mirage F1.C pilots at Orange AB during this time period, French Mirage pilots told this author that they would 'jettison the R.530E' if they anticipated their adversaries to be fighters. This is because it was useless against any manoeuvring targets and carried a severe weight and drag handicap if still on board when the dogfighting commenced.

In addition to the R.530E, the FAA's second batch of (seven) Mirage IIIEAs were also capable of employing the MATRA R.550 'Magic' IR missile, the first shipment of these being received mid-April 1982. Much more efficacious, the 'Magic' was a highly manoeuvrable AAM whose AD3601 seeker head had a relatively wide field of view and high gimbal limits (near 90°) allowing it to overshoot a hard-turning target and complete the intercept from 'outside the turn'. Larger than the comparable AIM-9, it had a greater range – approximately 6 miles (11km) – but was 'rear quarter' only, necessitating manoeuvring to a position behind the target in order to employ it. While two of the 196lb (89kg) 'Magics' could be carried (on the outboard wing pylons of the most ➤

THE PLAYERS: OPPOSING AIR FORCES IN THE FALKLANDS CONFLICT AS OF 1 MAY 1982

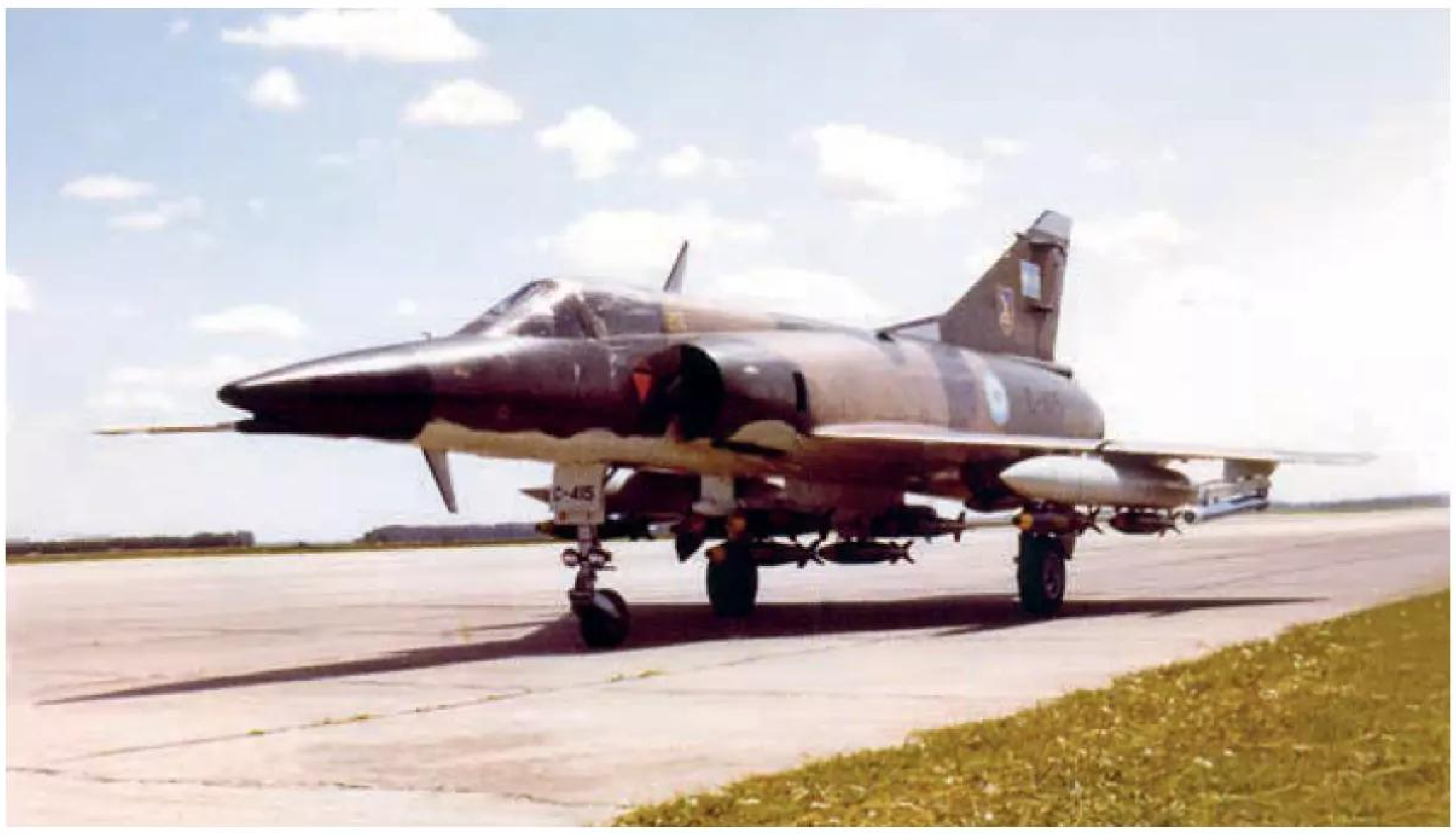
Argentina – Teatro Operaciones del Atlantico Sur
HQ: BAM Comodor Rivadavia – Brig Gen Ernesto Horacio Crespo

Interceptors – Grupo 8 de Caza		
Escuadrón de Caza Interceptora	BAM Comodoro Rivadavia	5 x Mirage IIIEA
	BAM Rio Gallegos	7 x Mirage IIIEA
Fighter-Bombers – Grupo 6 de Caza		
Escuadrón Aeromovil 1	BAN Rio Grande	9 x Dagger A
Escuadrón Aeromovil 2	San Julian Airport	10 x Dagger A
Attack – Grupo 5 de Caza		
I Escuadrón de Ataque	BAM Rio Gallegos	10 x A-4B Skyhawk
II Escuadrón de Ataque	BAM Rio Gallegos	10 x A-4B Skyhawk
Attack – Grupo 4 de Caza		
Escuadrón de Ataque	San Julian Airport	9 x A-4C Skyhawk
Bombers – Grupo 2 de Bombardeo		
Escuadrón de Bombardeo	BAN Almirante Zar	7 x Canberra B.Mk 62 2 x Canberra T.Mk 64
Comando de Aviacion Naval (COAN)		
2a Escuadrilla Naval Caza y Ataque	BAN Rio Grande	4 x Super Etendard
3a Escuadrilla Naval Caza y Ataque	ARA Veinticinco de Mayo (at sea)	8 x A-4Q Skyhawk

Note: 3a Escuadrilla moved its eight A-4Qs to BAN Rio Grande on May 9

United Kingdom – Royal Navy
Task Force 317.8 – RAdm John F. Woodward

HMS *Hermes*	8 x Sea Harrier	800 Squadron
	4 x Sea Harrier	899 Squadron
HMS *Invincible*	4 x Sea Harrier	801 Squadron
	4 x Sea Harrier	899 Squadron
Ascension Island	**Operational Reserve**	
	8 x Sea Harrier	809 Squadron
	To MV *Atlantic Conveyor* on May 5	
	To carriers on May 18-19, 1982	



Below left: The IAI Dagger was acquired as the FAA's only dual-role fighter-bomber, seen here carrying ten 250lb bombs and a pair of AAM 'training rounds'. **Hernan Casciani-Juan Carlos Cicalesi Archive**

Below: The Dagger's air-to-air armament was the Rafael Shafrir II IR missile, a rather large crude replication of the AIM-9B. **Hernan Casciani-Juan Carlos Cicalesi Archive**

recently received Mirage IIIEAs) instead of the single R.530E (on the centreline station), the Grupo 8 de Caza pilots were only starting to train on this new weapon when the war began.

THE IAI DAGGER A

To augment the sophisticated all-weather Mirage IIIEA, in 1978-80 the FM purchased the single-seat Israel Aircraft Industries (IAI) 'Nesher Ss', as well as four 'Nesher T' twoseat trainers. Developed as a 'clear weather air superiority fighter', the Nesher was renamed the 'Dagger A' for export. The FM recognised the aircraft's air-to-ground as well as air-to-air capabilities and purchased 35 as dual-role fighter-bombers. These equipped two squadrons of VI Brigada Aerea/Grupo 6 de Caza based at BAM Tandil, approximately 185 miles (300km) south of Buenos Aires.

The Nesher began as the IDF/AF's answer to the 1967 French arms embargo that denied the Israelis the 50 dual-role (air-to-ground as well as air-to-air) Mirage 5Js they had ordered. Using 'discreetly acquired' plans, IAI built 51 'copies', the first flying in 1969. Four years later IAI began producing the much-improved Kfir and the surviving Neshers were offered for sale. Aft of the cockpit the airframe was structurally identical to the Mirage IIIE, but the 20.75-inch (.527m) longer nose and the absence of the bulky, heavy Cyrano II radar allowed other avionics to be repositioned forward, providing increased fuel tankage (103 Imp gal/470 litres), boosting its effective combat radius to 500nm (922km) and increasing its 'on station time' about five minutes over that of the Mirage.

While the Daggers had a nominally improved 'time over target', their air-to-air warload was limited to a pair of Rafael Shafrir II ('Dragonfly') IR missiles. Patterned (as much as contemporary Israel technology allowed) after the early Raytheon AIM-9 it was larger in diameter, heavier and had a more restricted (stern only) employment envelope with an effective range of only 1.5nm (3km). The Dagger's sharply pointed nose contained no radar, but as a tactical deception measure fully half the nose was painted black to give the appearance of being the more capable Mirage.

Performance-wise the Mirage and Dagger were virtually identical with the latter being only 221lb (100kg) heavier. Having the same wings (375.13sq ft/34.85m²) and combat weight (approximately 20,000lb/9090kg with full weapons load and 60% internal fuel), the Mirage/Dagger had a wing loading of 53.3lb/sq ft (260.8kg/m²), which was good by contemporary standards.

However, while the large delta wing could generate a sharp initial turn (90° at low altitude/ 45-60° at higher levels), at maximum G it incurred a horrendous induced drag penalty that shed airspeed rapidly. The Atar 09C provided a thrust to weight ratio of .68-to-1, so it could only sustain 3-4 Gs depending on altitude.

Royal Navy Sea Harrier FRS.1s of 809 NAS with in-flight refuelling probes attached on their way south to the Falklands. **Editor’s collection**

Consequently, the Mirage/Dagger was a relatively poorly manoeuvring fighter if the pilot flew it to maintain its energy, but it had ‘one good turn’ available to point his cannon/missiles at a target or to overshoot an attacker.

THE’SHAR’

While the Mirage/Dagger design was optimised as a high-altitude supersonic interceptor – and its performance excelled above 20,000ft (6100m) – the much more modern BAE Sea Harrier was derived from the RAF’s ‘ground hugging’ Harrier GR.3. Its relatively small wing (201lb/sq ft/18.62m^2) and moderate combat weight (approximately 17,500lb/7030kg) gave it a high wing loading – 87lb/sq ft (377.55kg/m^2) and a correspondingly wider turning circle (than the Mirage/Dagger) at the same G. However, its exceptional thrust to weight ratio – 1.23:1 – allowed it to sustain much higher Gs (with correspondingly tighter turning circles) than the opponent, at least at low altitude. But power of the Rolls-Royce Pegasus 104 turbofan fell off markedly as altitude increased, limiting the ‘SHAR’s’ advantage to below 15,000ft (4570m). Consequently, if the ‘SHAR’ pilot could lure the Mirage/Dagger down to low altitude, negating the enemy’s performance advantage and enhancing his own, the Sea Harrier proved more manoeuvrable – unless of course the Mirage/Dagger pilot ‘cashed in all his knots’ for a decisive shot/defensive break.

To locate its adversary, the ‘SHAR’ mounted the Ferranti ARI.5979 Blue Fox radar – an I-band monopulse system with a 40-mile (75km) range. Eschewing the advancing pulse-Doppler technology of the day because the Admiralty did not anticipate employing the jet over land, the Blue Fox was an adaptation of the Sea Spray radar developed for the Westland Lynx helicopter, optimised to find ships in open ocean. Thus it was relatively simple and affordable –and was limited to level and ‘look up’ in its air-to-air mode. This was workable as long as the enemy approached at a higher altitude – which the Argentines conveniently did, at least at first.

The ‘SHAR’s’ ‘ace in the hole’ was the Raytheon AIM-9L Sidewinder missile. The ‘Lima’ was breakthrough technology by virtue of its new optical system (an Argoncooled Indium Antimonide detector element with much more discriminating IR sensitivity) and DSU-15NB active laser fuse that detonated the warhead before target passage. Thus the ‘SHAR’ pilot could employ his AAM for any aspect – including ‘head on’ – whereas the Argentine fighter pilots had to manoeuvre to the ‘six o’clock’ to use their own.

Finally, because of the small search volumes of the Cyrano and Blue Fox radars, both sides needed ‘ground control intercept’ (GCI support to locate their targets. For the FM fighters this was provided by a Westinghouse AN/TPS-43F S-band long-range air control and warning radar of Grupo 2 Vigilancia y Control Aereo.

This system was one of five air-transportable mobile units possessed by Grupo 2 VyCA (the others being located at the principle continental BAMs and BAN along the coast) and was deployed by FM C-130s to the Falklands on April 2, beginning 24-hour operations four days later.

First fielded in 1968 the TPS-43 had an effective range of 200nm (370km), altitude coverage up to 75,000ft (22,850m), and 10-second data refresh rate (6rpm antenna sweep). The FAA’s ‘F-model’ included IFF, ground clutter rejection and digital moving target indicator that allowed tracking enemy aircraft – and control of friendly ones – throughout the area. It was supplemented by an Argentine army ISC Cardion AN/TPS-44A long-range (275nm/500km) surveillance radar tied to its Skyguard anti-aircraft gun batteries. The inputs from these two systems were correlated in the Centro de Información y Control (Combat Information Centre or CIC) known as ‘Radar Malvinas’.

An AIM-9L Sidewinder missile mounted on a Sea Harrier FRS.1. **Editor’s collection**

The Sea Harrier CAPs were controlled by ‘radar picket ships’ – normally destroyers – stationed west of TF 317’s main body. RN surveillance and control radars had very similar capabilities with one notable exception. The older warships lacked modern effective ground clutter filters that permitted tracking aircraft over land. The only vessels with this capability were the modern Type 22 frigates (HMS *Broadsword* and *Brilliant*) but these lacked the 4.5in (11.4cm) guns needed for shore bombardment, so initially they were retained with the task force’s main body.

Ultimately, of course, in spite of all the technological advantages held by one side or the other, the final arbiter would be the training, skill and aggressiveness of each individual pilot.

THE ADVERSARIES MEET

The fighting over the Falklands started with a ‘bang’ – actually 21 of them – on ➤

May 1, when at 0446hrs (local time) that number of 1000lb (454kg) general purpose (GP) bombs rained upon Stanley Airport (called BAM Malvinas by Argentina) from a solitary Avro Vulcan bomber (codenamed 'Black Buck 1'), cratering the runway and damaging a hangar and an FM IA58 Pucara (Grupo 3 de Ataque) twinturboprop light attack aircraft. In response the FM scrambled a pair of Mirages – each carrying a single R.530E and a pair of 1700 litre (375 gallon) drop tanks – from BAM Rio Gallegos, 'Fiera' flight arriving on station around 0730 and, finding nothing, shortly thereafter they returned to base (RTBed).

Taking off from BAN Rio Grande at 0745 to relieve them were two Daggers – 'Toro' flight – each configured with a pair of Shafrir IIs and three 1300 litre (285 gallon) drop tanks. The 'Toros' clashed with a pair of 'SHARs' (801 NAS) but both sides lost sight of the other immediately after 'the merge' – with the Daggers passing head-on 4,000ft (1220m) above the Sea Harriers – and the engagement proved inconsequential.

In between 'Fiera' and Toro' flights, a dozen Sea Harriers (800 NAS) delivered thousand-pounders and BL755 CBUs against Stanley and Goose Green airfields, destroying a Grupo 3 Pucara at the latter, while six 'SHARs' (801 NAS) established three Combat Air Patrols (CAPs – flown as orbits until enemy aircraft were seen approaching) between East Falkland and the fleet (90nm/167km to the east-northeast of Port Stanley), resulting in the engagement described above.

Once the Fuerza Aerea del Sur (Southern Air Command) learned of the 'Black Buck 1' raid on Stanley airfield, HQ ordered Grupo 8 to launch a pair of Mirages, led by squadron commander Major Jose Sanchez. **Hernan Casciani-Juan Carlos Cicalesi Archive**

Grupo 8 established two 'deployed squadrons', basing the seven more capable 'second batch' Mirages at BAM Rio Gallegos with 13 pilots. Capt 'Paco' García-Cuerva is standing third from right and 1st Lt Carlos Perona is kneeling, first on the left. **Museo Malvinas Oliva Archive**

Mid-morning two Mirage two-ships returned ('Tabion' and 'Limon' flights), sparring with two Sea Harrier CAPs, in one instance firing an R.530E – sure enough – to no effect. These were followed by a pair of Daggers ('Foco' flight) providing top cover for the first waves of Skyhawk attack jets (Grupos 4 and 5) attempting to locate and attack TF 317.

Grupos 4 and 5 launched 28 A-4 'armed reconnaissance' missions, but none of them were able to locate RN targets. Additionally COAN's 2a Escadrilla de Caza y Ataque launched two Exocet-armed Super Etendards but these had to abort their mission due to air-to-air refuelling failure. Of the six Canberra sorties, none found the British fleet.

'Foco' also clashed inconclusively with 'SHAR' CAPs. A mid-day follow-up high altitude sweep by another pair of Daggers ('Ciclon' flight) found nothing.

The two pairs of Mirages returned in midafternoon. One of them ('Buitre' flight, taking off at 1540hrs) also found nothing, but the second, 'Dardo' flight, taking off at 1545hrs, was the first to participate in a decisive engagement against the Sea Harriers. Having learned from the morning's disappointing experience with the R.530E, Grupo 8 armourers added a pair of 'Magics' to the Mirages' weapons load despite the caution in the flight manual discouraging this configuration.

About the same time – from 1530 to 1550hrs – Grupo 6's II Escuadrón launched nine of its 10 Daggers in a maximum effort from San Julian airport. Four swept ahead to clear out the 'SHAR' CAPs, three formed a 'strike package' looking for RN warships while two more covered them. At 1555hrs, from BAN Rio Grande another pair of Daggers ('Rubio' flight) was scheduled to launch to provide egress protection, but in the event, only one got airborne.

The opposition was six Sea Harriers CAPing above an expansive undercast at 15,000ft (4570m) in three locations along a north-south arc west of TF 317. Meanwhile approaching Port Stanley were three RN warships – the destroyer HMS *Glamorgan* with frigates *Alacrity* and *Arrow* – intent on conducting a late afternoon bombardment of Stanley Airport. The small task group arrived off their target and began shelling at 1630hrs, about the time the first FM fighters approached the scene.

DEFEATING THE MIRAGE IIIEA

British GCI was by HMS *Glamorgan* and the destroyer's air controllers spotted the pair of Mirages approximately 120nm (193km) away, driving in at 35,000ft (10,500m) altitude. As they got closer, *Glamorgan* alerted one of the CAPs – manned by RAF Flt Lt Paul Barton (on an exchange tour, flying XZ452) and Lt Steve Thomas (in XZ453) – and at 40nm (7 4km) range vectored them west towards the 'bogeys'. The 'SHARs' were in a standard battle formation: line abreast one mile (1.85km) spread with Thomas on the left, loitering at 300kts (555kph) to conserve fuel. They pushed over to 11,000ft (3355m) and accelerated to 400kts (740kph) to meet the fast-approaching threat.

'Dardo' flight was being led by Captain (Capt) Gustavo Argentino 'Paco' Garcia-Cuerva (in 'I-019') with 1st Lt Carlos Perona (in 'I-0151) on his wing. There is at least one opinion, reportedly supported by photographic evidence, that the two pilots were actually in the opposite 'tail number' aircraft. However, until that is verified as fact, these are the aircraft assignments traditionally given in all previous histories.

The pair flew a textbook left echelon attack formation (called 'fighting wing' with Perona following at 1800ft (500m), offset 30° to port. 'Radar Malvinas' called out the challenging 'SHAR' flight and, at 500kts (925kph) 'Dardo' 'ramped down' towards

FUERZA AÉREA ARGENTINA AND COAN COMBAT AIRCRAFT INVENTORY – 1 MAY 1982

Aircraft Type	Number Acquired	Number Remaining	Number Operational	Number Lost
Mirage IIIEA	17	16	12	2
Mirage IIIDA	2	1	-	-
Dagger A	35	34	26	11
Dagger B	4	3	-	-
A-4B	50	36	26	10
A-4C	25	16	12	9
A-4Q	16	10	8	3
Super Etendard	5	5	4	0
Canberra B.62	10	8	7	2
Canberra T.64	2	2	2	0

Grupo 8 launched three two-ships of Mirages IIIEAs that morning, challenging SHAR CAPs in inconclusive engagements. **Pablo Calcaterra Collection**

Capt Gustavo Argentine 'Paco' Garcia-Cuerva, after soloing the Mirage IIIEA. **Museo Malvinas Oliva Archive**

12,000ft (3660m) eastbound along the northern coast to engage, pointing directly at Thomas's jet.

Thomas got the first radar contact and Barton quickly passed him the leader's role, and – needing a positive visual identification (VID) – called for a 'shooter-eye' attack. In this case Thomas became the 'eyeball', approaching the enemy head-on and would call 'bandit, bandit, bandit' if the 'bogeys' were Argentine. Barton descended, accelerating even more – to 550kts (1018kph) – as he swung wide to the right to get 'turning room' so that he could enter as the 'shooter' from an advantageous position (behind the 3/9 o'clock line).

As they approached 'the merge' at eight miles (15km) – looking down against the fluffy white tops of the undercast, Garcia-Cuerva called, "There they are, number two. Let's get them!" The two Mirage pilots jettisoned their external fuel tanks, but one of Perona's failed to release.

At the same range, against a blue-sky background Thomas VIDed the Mirages, mistaking the jettisoning drop tanks for missile firings that went awry. By this time Barton had locked-up the enemy wingman and got 'tally two' at five miles (nine km). He began turning towards them as Thomas met them 'beak to beak', carving right across the leader's canopy with only 100ft (30m) between them, crossing the wingman 'close aboard' immediately thereafter.

Entering unseen from the lower left, Barton curved upwards to engage the trailing Mirage, shedding knots rapidly in the 6G climbing turn, squeezing off a 'snapshot' with his Aden cannon as Perona's Mirage flashed past his nose. Unaware, the Mirages began a smooth 2-3G climbing left turn so that GardaCuerva could visually reacquire Thomas's jet, hoping (according to Perona) to engage the Sea Harriers in a 'vertical rolling scissors'. The gentle pull maintained the Mirages' energy but proscribed a wide left-hand climbing turn.

By the time Barton completed his conversion to Perona's six o'clock and put his nose on the Mirage's tailpipe he was down to 350kts (650kph) but was in the 'heart of the envelope' for the AIM-9L, even with 150kts (280kph) of 'opening velocity'. Hearing the telltale growl in his headset, he uncaged the Lima's seeker, heard the confirming 'nee-neenee' (signalling the missile was tracking the target) and let it fly.

"At first I thought it had failed," Barton recalled, "It came off the rail and ducked down ... it took about half a mile for it to get its trajectory sorted out, then it picked itself up and for the last half mile just homed straight in. The missile flight time was about four seconds, then the Mirage exploded in a brilliant blue, orange and red fireball."

Looking over his left shoulder, Garda-Cuerva saw the approaching missile and shouted for Perona to "break" but it was too late. Perona had just initiated a rolling pull towards Thomas's 'high six' (to enter a vertical scissors) when the missile impacted and as his Mirage disintegrated around him he ejected from the flaming wreckage.

Now Garda-Cuerva saw that he was '1-v-2' and immediately went into a hard 'slicing' defensive turn, spiralling downwards into the cloud deck 8000ft (2440m) below. This gave Thomas plenty of vertical turning room and he followed, stating later, "I rolled into a vertical descent behind him, locked on one of my missiles and fired it. The missile streaked after him and just before he reached the cloud I saw it pass close to his tail. Then both the aircraft and the missile vanished (into cloud)." Thomas followed through the undercast searching for evidence that his target had crashed, but there was none.

By 1632hrs the first-ever decisive Sea Harrier engagement was over, with one confirmed 'kill' and one 'probable'. Following this engagement GardaCuerva tried to land at Stanley Airport but because the airfield was under bombardment permission was denied. He attempted to do so anyway and was shot down by Argentine army 35mm AA guns. Believing Thomas's missile had damaged the Mirage sufficiently that it could have never flown out of Stanley, the RN pilot was later given credit for the victory.

Meanwhile, victorious, Barton and Thomas headed back to HMS *Invincible* for more fuel and missiles. ➤

The morning missions carried the single MATRA R.530E which proved singularly ineffective against the Sea Harriers. **Hernan Casciani-Juan Carlos Cicalesi Archive**

RN/FAA SEA HARRIER DEPLOYMENT FOR FALKLANDS CAMPAIGN

Aircraft Carrier	Unit	Serial	Notes:
HMS *Hermes*	**800 Sqn**	XZ450	LOST 4.5.82 – shot down by 35mm AAA, Lt Nick Taylor KIA
		XZ459	
		XZ460	1.5.82 – destroyed w/CBU FAA Purcara A-527 at Goose Green
		XZ492	21.5.82 – shot down FAA A-4C C-309 by Lt Cdr Neill Thomas
		XZ496	21.5.82 – shot down FAA A-4C C-325 by Lt Cdr Mike Blissett
		XZ500	21.5.82 – shot down CANA A-4Q 3-A-314 by Flt Lt John Leeming
		ZA192	23.5.82 – destroyed Puma AE-500 by Flt Lt David Morgan
			LOST 24.5.82 – exploded after T/O Lt Cdr Gordy Batt MIA/killed
		ZA193	21.5.82 – shot down FAA Dagger C-410 by Lt David Smith
	899 Sqn	XZ455	1.5.82 – shot down FAA Dagger C-433 by Flt Lt Robert Penfold
			21.5.82 – shot down FAA Dagger C-409 by Lt Cdr Rod Frederiksen
		XZ457	21.5.82 – shot down CANA A-4Q 3-A-307 by Lt Clive Morrell
			24.5.82 – shot down two FAA Daggers C-419 and probably C-430 by Lt Cdr Andy Auld
		XZ494	
		ZA191	
HMS *Invincible*	**801 Sqn**	XZ493	
		XZ495	
		XZ498	
		ZA175	21.5.82 – shot down FAA Dagger C-407 by Lt Cdr N. D. Ward
	899 Sqn	XZ451	1.5.82 – shot down FAA Canberra B-110 by Lt Alan Curtis 1.6.82 – shot down FAA Hercules TC-63 by Lt Cdr N. D. Ward
		XZ452	1.5.82 – shot down FAA Mirage IIIEA I-015 by Flt Lt Paul Barton LOST 6.5.82 with XZ453, Lt Cdr John Eyton-Jones MIA/killed
		XZ453	1.5.82 – damaged FAA Mirage IIIEA I-019 by Lt Steve Thomas
			LOST 6.5.82 with XZ452, Lt Alan Curtis MIA/killed
		XZ456	LOST 1.6.82 – shot down by Roland SAM, Flt Lt Ian Mortimer OK
MV *Atlantic Conveyor*	**809 Sqn**	XZ499	To *Hermes*/800 Sqn on May 18 8.6.82 – shot down FAA A-4B C-204 by Lt David Smith
		ZA176	To *Hermes*/800 Sqn on May 18
		ZA177	To *Hermes*/800 Sqn on May 18 8.6.82 – shot down two FAA A-4Bs C-226 and C-228 by Flt Lt David Morgan
		ZA194	To *Hermes*/800 Sqn on May 18 8.6.82 – shot down FAA Dagger C-437 by Flt Lt Mike Hale
		XZ458	To *Invincible*/801 Sqn on May 18
		XZ491	To *Invincible*/801 Sqn on May 19
		ZA174	To *Invincible*/801 Sqn on May 19 LOST – 29.5.82 when rolled off deck in heavy seas, Lt Cdr Mike Broadwater OK
		ZA190	To *Invincible*/801 Sqn on May 18/19 8.6.82 – shot down two FAA Daggers C-403 and C-404 by Lt Cdr N. D. Ward

INTRODUCING THE DAGGER

The four sweeping Daggers made a couple of threatening feints designed to draw off 'SHAR' CAPs then RTBed as 'Torno' flight – three Daggers, each hauling a pair of 550lb Spanish ExPal (short for 'Explosivos Alaveses', the manufacturer) BRP-250 parachute-retarded bombs and three 1300-litre (285 Imp gal) tanks – descended through the undercast (ragged 1000ft/300m ceiling, tops at 4000ft/1200m) to about 50ft (15m) off the waves approximately 85nm (160km) from West Falkland's shores. Consequently, they went unseen by *Glamorgan's* GCI.

Flying at 420kts (775kph) Capt Norberto Ruben Dimeglio led his small formation eastbound along the northern coastlines, using the islands' terrain for concealment as he swung around East Falkland and approached Port Stanley from the northeast entirely unmolested by Sea Harrier CAPs.

As the formation passed Pebble Island, at '3 o'clock' they spotted a Sea Harrier beneath the overcast making a wide turn away from them. It was probably Thomas looking for the wreckage of GarciaCuerva's Mirage.

Five miles (eight km) offshore he spotted the three RN warships bombarding Stanley Airport and immediately called for an attack. The three Daggers completely surprised the task group, slightly damaging all three vessels with 30mm cannon fire and their bombs' near-misses.

Breaking right in full reheat the three 'Tornos' headed northwest, crossing West Falkland supersonic at low level, egressing separately and, in and out of the low clouds, losing sight of one another. Passing San Carlos Sound, Dimeglio called for "mil(itary) power" and a climb to save gas. 'Torno l' zoomed to 42,000ft and 'Torno 3' to 30,000ft while 'Torno 2' lagged behind at 21,000ft.

Alerted by Glamorgan that the task group was under air attack, a pair of 'SHARs' raced to the scene and when the 'Tornos' 'popped up', they were vectored into an eight-mile (15km) 'tail chase'. The Sea Harriers locked onto the lowest Dagger, 1st Lt Gustavo Aguirre Faget, but even at full power the subsonic Sea Harriers closed agonisingly slowly.

Three Daggers on the end-of-runway hardstand at San Julian airport. **Hernan Casciani-Juan Carlos Cicalesi Archive**

Two Daggers, each armed with two BRP-250 bombs on their centreline stations, ready for take-off from San Julian airport. **Pablo Calcaterra-Jose Luis Martinez Collection**

Meanwhile, at 30,000ft (9150m) 'Fortin' flight had just arrived over East Falkland when 'Radar Malvinas' reported the 'bandits' chasing 'Torno 2' 16nm (29.5km) to the northwest. Capt Guillermo Donadille and 1st Lt Jorge Senn 'snapped' to 320° heading, jettisoned their drop tanks and 'plugged in' reheat, accelerating to Mach 1.4, racing to the rescue.

Crossing West Falkland the 'SHARs' got within 3nm (5.5km) of 'Torno 2' as, behind them, 'Fortin' flight closed to two miles (3. 7km), but lacking a search radar and looking directly into the late afternoon sun the two FAA pilots could not locate their prey. After a 70nm (130km) chase the 'SHARs' gave up – either concerned about running low on fuel in a fruitless pursuit, or being warned that they too were being chased – and 'split-Sed' out of the fight. 'Fortin' flight spotted the Sea Harriers as they 'sliced' down to the left but, also low on fuel, decided not to follow.

DEFEATING THE DAGGER

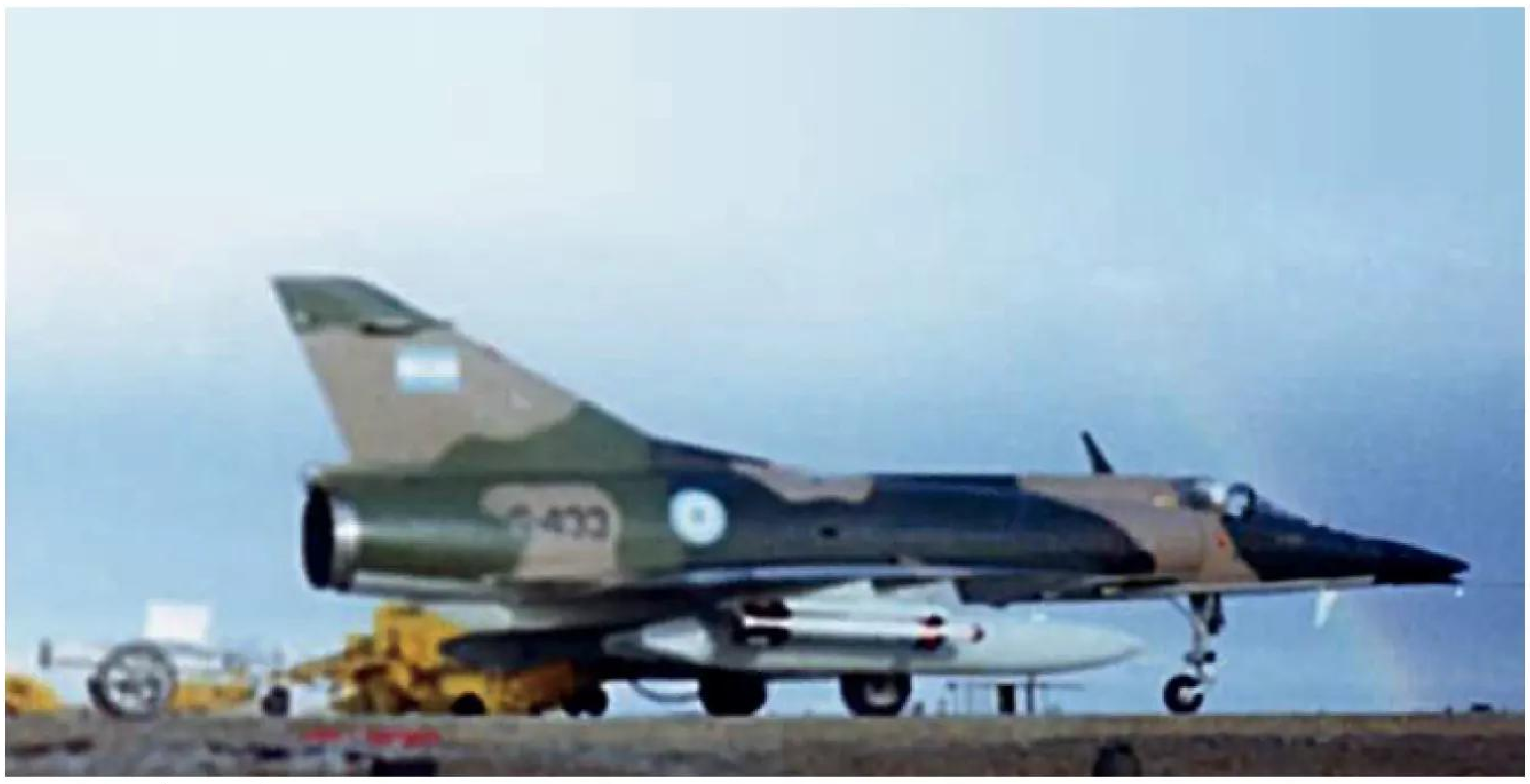
At 1640hrs, the third 'SHAR' CAP (800 NAS) was engaging 'Rubio' flight. Unfortunately 1stLt Jose 'Pepe' Ardiles (in C-433) elected to continue the mission in spite of his flight leader's ('Rubio One' ➤

Flying into the setting sun, their mission complete, two Daggers RTB on wing of Grupo 1 (photo-reconnaissance) Learjet, T-23. **Hernan Casciani-Juan Carlos Cicalesi Archive**

'Torno' flight pilots Lt Roman, Capt Dimeglio and Lt Aguirre after their anti-ship attack mission. **Museo Malvinas Oliva Archive** was Capt Carlos Rohde) ground abort. Flying eastbound along the southern coast of East Falkland 'Radar Malvinas' vectored him against a single target (on radar) approaching from the east-northeast. The 'single target' was actually a pair of Sea Harriers being flown by Lt Martin Hale with Flt Lt Tony 'Bertie' Penfold (another RAF exchange pilot) in battle formation. 'Radar Malvinas' vectors pointed Ardiles directly at Hale's Sea Harrier.

Approaching head-on once again, with the 'SHARs' climbing through 20,000ft (6100m) and Ardiles descending from 33,000ft (10060m), at seven miles (13km) the Dagger pilot picked up Hale's jet visually, called "A la vista!" (Tallyho!') and hosed off a Shafrir, well outside its envelope. Nevertheless Hale respected the missile (as a fighter pilot you just never know – the first time you believe intel is the time the bad guys kill you with something they're not supposed to have!) and broke hard downhill, slicing towards the clouds, bottoming out at 5000ft (1525m) as the missile went ballistic and dropped into the undercast.

By this time 'Radar Malvinas' reported that there were two adversaries, so Ardiles immediately went into a hard climbing turn in full 'burner, but he was unable to escape Penfold (in XZ455). With the Lima growling angrily in his headset, Penfold unleashed it inside three miles (five km) and by the time it shot across the distance, Ardiles had completed the turn. The missile ran up the Dagger's tailpipe and detonated, 'shredding' the Argentine jet. It erupted into another fireball and fell in pieces in Choiseul Sound and on lively Island. The pilot did not survive.


1st Lt José 'Pepé' Ardiles flew Dagger C-433 – shown here taxiing out with its Shafrir AAMs underwing – on a single-ship mission covering the egress of 'Torno' flight. He engaged two Sea Harriers and lost his life in accomplishing his mission. **Pablo Calcaterra-Jose Luis Martinez Collection**

A FIGHTER PILOT'S ASSESSMENT

May 1 was a day of reckoning for both sides. Once the RAF and RN initiated combat operations to retake the Falklands, the FAA launched 25 'air cover' sorties – 12 by Mirages and 13 by Daggers – attempting to protect 39 attack sorties: three Daggers, six Canberras, 28 Skyhawks and a pair of Super Etendards. They lost two Mirages and one Dagger in the attempt.

The final 'SHAR' victory of the day occurred at 1704hrs, 48nm/90km northwest of HMS *Invincible*, when Lt Cdr Mike Broadwater and Lt Al Curtis (801 Sqn) intercepted a three-ship formation of Grupo 2 Canberras at 50ft (18m) off the water. Curtis (in XZ451) shot down one with an AIM-9L killing both crewmen. The other two Canberras escaped. Sea Harriers suffered no casualties.

Obviously the Mirage was outclassed, lacking the endurance, radar and weapons to successfully challenge the 'SHAR'. Its Israeli cousin, the Dagger, was at an even worse disadvantage. Thus, on the very

Following the losses to SHARs on May 1, the Mirages were relegated to flying 'decoy', and some nocturnal escort, missions while the Daggers soldiered on in the air-to-surface role flying high-speed low-level attack missions against British ships once the amphibious counter-invasion began. **Pablo Calcaterra-Jose Luis Martinez Collection**

THE COMBATANTS COMPARED – A FIGHTER PILOT'S ASSESSMENT

Attribute	**BAe Sea Harrier FSR.1**	**Dassault Mirage IIIEA**	**IAI Dagger A**	**Results/Assessment**
Powerplant	21,500lb thrust Rolls-Royce Pegasus 104	13,668lb thrust SNECMA Atar 09C-3	13,670lb thrust IAI-Bedek copy of the SNECMA Atar 09C-3	
Dimensions				
Wingspan	27ft 3in	26ft 11.5in	26ft 11.5in	
Length	46ft 3in	49ft 3.5in	51ft 0.5in	
Height	12ft 2in	13ft 11.5in	13ft 11.5in	
Wing Area	201.1sq ft	375.13sq ft	375.13sq ft	
Weight				
Empty	14,500lb	15,542lb	15,763lb	
Loaded	26,500lb	30,203lb	30,200lb	
Thrust/Wt	1.23:1	0.68:1	0.68:1	Sea Harrier Superior
Wing Load	87.0lb/sq ft	53.3lb/sq ft	53.3lb/sq ft	
Performance				
Max speed	720mph at S/L	863mph at S/L	857mph at S/L	Mirage/Dagger Superior
Mach Limit	1.25 Mach	2.2 Mach	2.2 Mach	Mirage/Dagger Superior
Turning Advantage	Superior due to ability to sustain over 6 Gs	Inferior due to excessive energy loss if over 3 Gs	Inferior due to excessive energy loss if over 3 Gs Inferior	Sea Harrier Superior due to ability to sustain higher G turns
Combat Radius	300 miles	450 miles	500 miles	
Climb Rate	8,200ft/min	2,030ft/min	12,303ft/min	
Service Ceiling	51,200ft/min	48,000ft/min	47,200ft	
Armament	2 x 30mm ADEN cannon; 2 x AIM-9L IR missiles	2 x 30mm DEFA cannon; 1 x MATRA R.530E and/or 2 x MATRA R.550 Magics	2 x 30mm DEFA cannon; 2 x Rafael Shafrir II IR missiles	Sea Harrier Superior due to its all-aspect IR missiles
Radar	Ferranti Blue Fox 40nm range	Thomsen-CSF Cyrano II 25nm range	ESD Aïda range-only radar	Sea Harrier's radar has longer range and greater search volume

first day of battle, the FAA discovered – for the high cost of three jets and the lives of two pilots – that it could not overcome the Sea Harrier's superiority in the combat arena.

Additionally the training of the Argentine fighter pilots – notwithstanding their obvious courage – had not prepared them to meet the likes of RAF (on exchange) and RN Sea Harrier pilots. Their formations, weapons employment and engaged tactics were all inferior. Engaging 2-v-2 with only one adversary in sight ('Dardo' flight vs Barton/Thomas) while in a formation providing no mutual support ('fighting wing') doomed two of them. Turning in front of an AIM-9-armed opponent while in full afterburner (an enormous heat signature against a cold blue sky background) killed another.

During the next six weeks Grupo 8 Mirages flew another 35 combat sorties, mostly as 'decoy' missions attempting – usually unsuccessfully – to distract 'SHAR' CAPs from the Dagger and Skyhawks ingressing at much lower altitudes.

However, the FM did discover that TF 317 had no airborne early warning (AEW) and almost no over-land surveillance capability. Therefore, low altitude ingresses using terrain masking effectively allowed them to avoid long range detection from GCI – as well as the 'SHAR's' Blue Fox radar – and get close to their targets before being engaged. Consequently, Grupo 6's Daggers dispensed with carrying Shafrir missiles and – once the British forces came ashore from San Carlos Water – continued the campaign as fighterbombers, hurling 'iron bombs' at RN ships in spectacular high-speed low-level 'one pass, haul ass' attacks. Nevertheless, another nine Daggers – and in two cases entire three-ship attack formations – were intercepted and shot down by the BAe Sea Harriers.

In the final analysis the 'SHARs', while unable to completely protect the Task Force, certainly minimized the damage Argentine Daggers and Skyhawks could have caused and in the process destroyed 22 FM and naval aircraft for no losses. A 22:0 kill ratio is an extraordinary achievement, bettered by only one other modern fighter – but as I've stated before, that is another great story about another great jet! ■ *Words: Douglas C. Dildy*

A Northrop AT-38B Talon Lead-in Fighter Trainer of the 479th Tactical Training Wing. **Editor's collection**

A Yank in Her Majesty's service

My name is Steve Deaux and I flew Harrier GR.3s with the Royal Air Force as the USAF Exchange Officer in Number 4 Squadron at RAF Gutersloh, West Germany, from February 1987 to March 1990. These are my experiences as a Yank in Her Majesty's Service.

HARRIER
VSTOL FIGHTER

The flying suit patch of a Harrier pilot. **Steve Deaux**

A Hawk T.1 of 2 TWU at RAF Brawdy carrying practice bombs, a rocket pod and an Aden cannon belly pack. **Editor's collection**

As every good fighter pilot story begins – 'There I was…', preparing to fly a Basic Fighter Manoeuvres (BFM) sortie with a student when my Flight Commander, Stan Miller, said: "Hey Steve, there's a Brit Harrier slot opening up and they're looking for volunteers. You interested?"

I said: "Lemme think about it." And out the door we stepped to our awaiting AT-38B Talon jet trainer. As I did the walk-around, I thought about that Harrier assignment. I didn't know very much about the jet or the assignment. An A-10 squadron mate of mine in Louisiana, Mick Dove, had taken the Exchange job at Gutersloh, Germany, several years earlier. I wondered, was this the same assignment?

Realising that my time as a Lead-in Fighter Training (LIFT) Instructor would draw to a close in less than a year, I thought, yeah, that sounds pretty cool. As I climbed the ladder to strap-in, I put my helmet on and called Stan back at the squadron: "Red Devil Operations, this is Dough boy, put me in for that 'Jump Jet' slot." And off we flew on our BFM sortie in the beautifully clear New Mexico afternoon sky. I didn't really think I'd make the cut for the assignment but was intrigued, nonetheless.

A few weeks later, I heard through the grapevine that I was indeed the 479th Tactical Training Wing's nominee for the Exchange Officer slot to Gutersloh, Germany. I still wasn't going to get my hopes up too high knowing that the selection process was long and that there would probably be stiff competition.

Our Air Force Military Personnel Center contacted me and had me fill out a full application, provide an in-depth resume, personal photo and even a family photo for the final selection board.

About one month later, we learned that we would be heading off to England to begin training for the Harrier Exchange. This would prove to be one of the greatest adventures of our lives.

TO ENGLAND AND INTO THE RAF

It was a cold February day when my wife, Becky, our six-year-old son, Tim, and I arrived in London. We had a few days there to visit the USAF Exchange Office and get to know the staff that would support our many administrative needs for the next three years. We also had our first chance to take in the sights of London, ride the tube and sample some fine English cuisine. Then we were off to our new home for the next year: RAF Wittering.

A Hawk T.1 of 79 Squadron. **Editor's collection**

My first refuelling with a Victor tanker in a 233 OCU Harrier T.4. **Steve Deaux**

There we met the current Harrier Exchange pilot on Number 1 Squadron, Dave Wallace, and his replacement, Pitt Merryman. The guy I was replacing was Marc 'Rambo' Frith, whose brother Gary I had flown A-10s with in Louisiana. There were, in fact, two USAF Harrier slots: one at Wittering on 1 Squadron and the other at Gutersloh on 4 Squadron. In addition, Gutersloh had a US Marine pilot, Gary Pheasant, flying with 4 Squadron and a US Navy pilot, John Sunderland, on 3 Squadron. So I would not be the lone Yank with the RAF Harrier force.

This next year would prove to be one of the most demanding of my career. I had close to 1500 hours of fighter time flying A-10s with the 75th Tactical Fighter Squadron at England AFB, Louisiana, and then as a LIFT instructor in the AT-38 with the 434th Tactical Fighter Training Squadron at Holloman AFB, New Mexico. I had also taught Air-to-Ground Academics with the 465th Tactical Training Squadron, so I felt I had a good background in weaponry and Close Air Support. But I had no idea what a challenge lay ahead.

My first step in training for the Harrier would be nearby at RAF North Luffenham, where I would receive my initial flying gear and undergo the RAF's physiological training. This was very similar to the USAF version with a half day of academics followed by the altitude chamber. This allowed me to become familiar with 'Brit' terminology and use of their equipment. Of note, the RAF's flying helmet was much heavier and considered more a 'crash helmet', as opposed to the USAF's view of a lightweight shell to house the headset and oxygen mask. Otherwise, this portion of the initial training was fairly quick and easy.

THE HAWK AND LOW LEVEL FLYING

The next step in my training began with a long train trek to RAF Brawdy in Wales for the Short Tactics Course flying the Hawk T.1 trainer with 79 Squadron. I was originally scheduled to get a couple of familiarisation rides in the Jet Provost (JP) trainer, but they were undergoing maintenance work so it was decided to give me a couple of Hawk simulator trips and forgo the JP flights.

Flying the Hawk would initially feel a lot like what I had just come from in the AT-38: basic weapons attack, some BFM, and lowlevel flying. The aircraft itself was great, simple and straightforward, although having just the single engine was new for me and I had to learn about simulated flame-out landings. The bombing and strafing at Pembrey Range was fun and I felt like I knew what I was doing.

Dealing with the unpredictable weather in Wales and flying 250ft low-level nav sorties in unfamiliar terrain at 420 knots, however, proved to be quite another thing. Coming from the A-10, my brain was 'geared' to 240-300 knots and 300-500ft flying. Then in the AT-38, although we flew low-level navigation flights at 360-420 knots, we used two very 'canned' low-level routes in very distinguishable New Mexican desert ➤

At last an operational aircraft! A 4 (AC) Squadron Harrier GR.3. **Editor's collection**

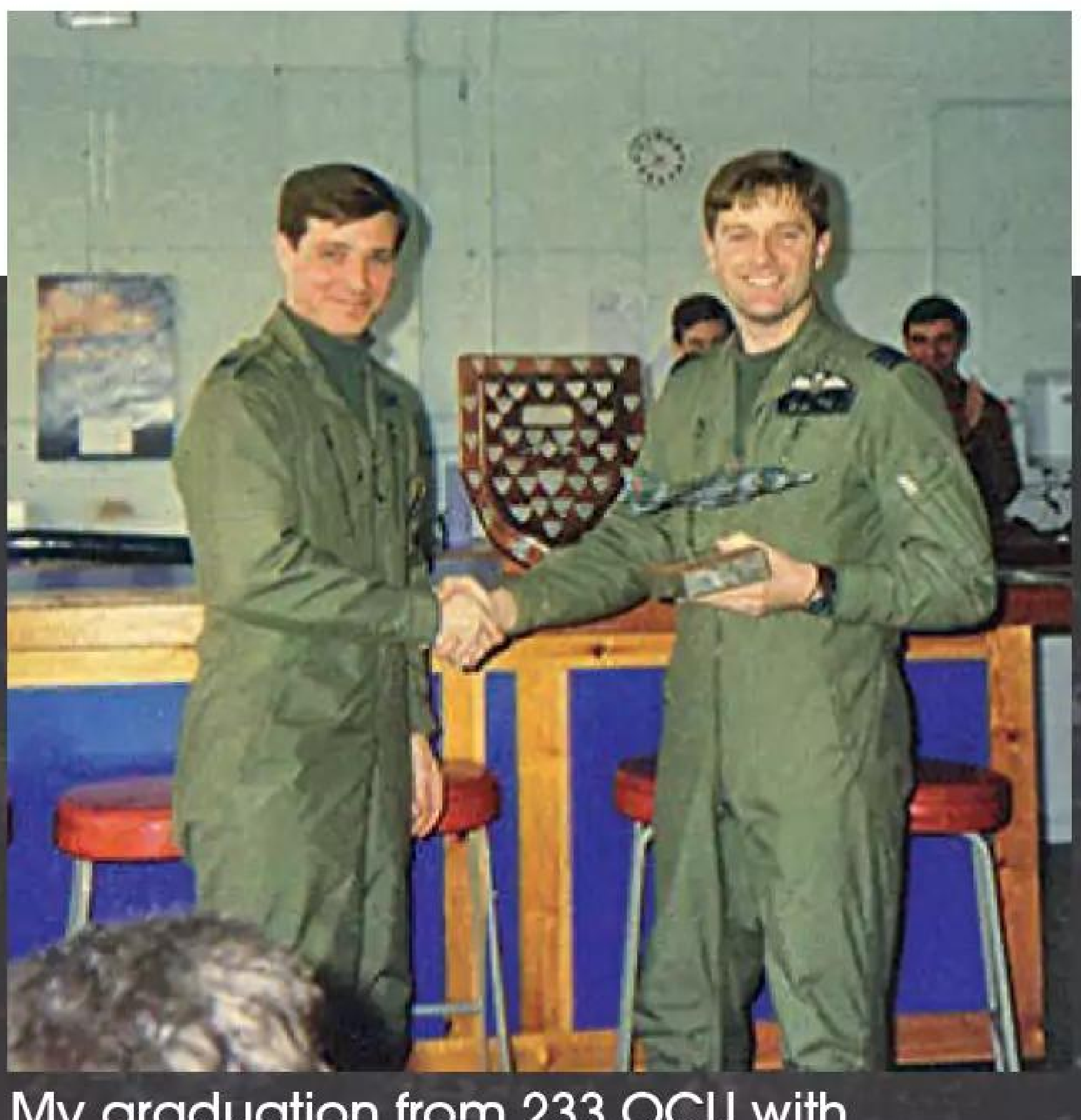
terrain in almost always 100-mile visibility, and we limited the altitude to 500 feet.

Additionally, the low-level nav portion of the LIFT syllabus was only two flights out of 21 sorties. Here at Brawdy, the major thrust of the training was low level nav. Flying a new jet in a new environment with a new set of rules and (believe it or not) a new language was a big deal to me. And I struggled. Add to this the fact that just before I arrived for training, an American Exchange officer had been killed in a Jaguar accident and the new US Navy Exchange officer had 'washed out' of training before finishing the Hawk Course. So I felt the pressure was on to perform, and to perform exceptionally well, as the Harrier and Jaguar were the RAF's premier fast jets, and only the best got a chance to fly them.

A typical Hawk sortie would be leading a two-ship formation on a random 250-foot low level navigation route with three 'targets' which varied from a small foot bridge to a phone box or a road crossing. Some flights were flown against a 'Bandit' which was another Hawk instructor pilot who would 'bounce' the flight at various points along our intended route trying to disrupt or delay our time-on-target (TOT). This was without the aid of an inertial navigation system or moving map indicator. We used a 1:250,000 scale map for the low-level route, 1:50,000 scale target maps and flew 'old-school' time-distanceheading basic nav.

One of the biggest challenges for me was thinking and looking ahead of the aircraft – farther ahead than I was used to at slower speeds and from a few hundred feet higher up. Things look quite different from 250 feet than they do at 500 feet. And on the simulated bombing runs, from the initial point (IP) to the target, we dropped down to 100ft and accelerated to 480 knots.

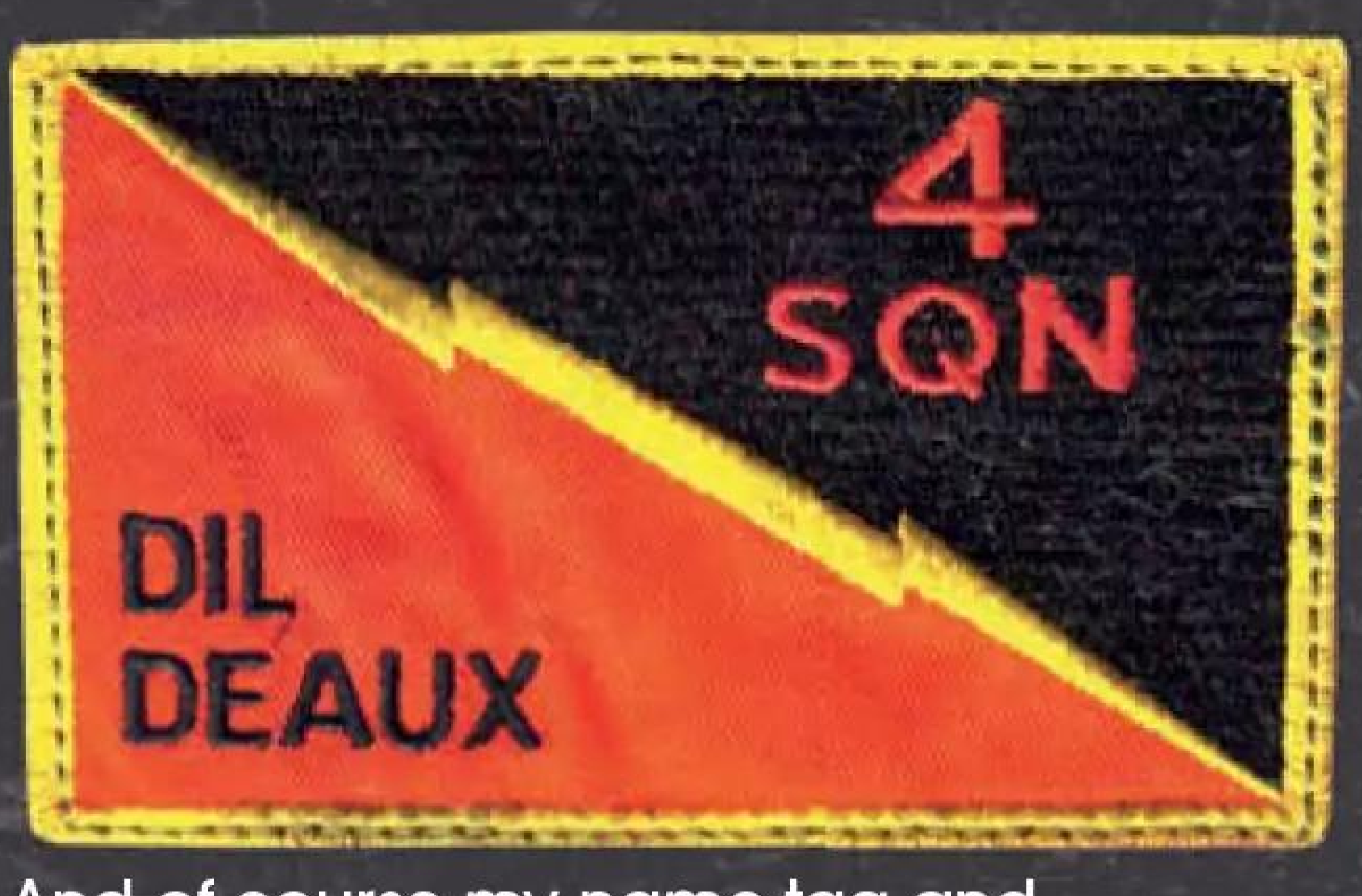
Moving across the ground at close to eight miles a minute, you don't have



My graduation from 233 OCU with Squadron Leader Moran. **Steve Deaux**

IV
IV
ROYAL AIR FORCE
IN FUTURUM VIDERE

Off to 4 (AC) Squadron and a new patch for my flying suit! **Steve Deaux**



And of course my name tag and nickname! **Steve Deaux**

A Gazelle HT.3 from RAF Shawbury. Harrier pilots flew helicopters to introduce them to vertical flight. **Editor's collection**

A Harrier T.4 two-seat trainer of 233 OCU. **Steve Deaux**

much time to visually acquire a target, manoeuvre your aircraft to overfly it and put a (simulated) bomb on it. I often didn't see the target, or saw it too late to effect a weapons delivery, so we would have to circle back around and try a re-attack. In a tactical scenario, you don't want to re-expose yourself to the threat by re-attacking – so this was not a great idea.

Just as I was finishing up the Hawk phase of my training, I learned my father was critically ill and in the hospital back in our hometown in Florida. I sent my wife and son home and planned to fly my last Hawk sortie the following day, then fly back to the US. Although mentally distracted, I passed my last trip and then bid farewell to my instructors at Brawdy, then flew back to the states on emergency leave. When I got back home, I learned my dad had passed away that morning. I was heartbroken that I didn't get the chance to say goodbye.

After the funeral, and some time with my family, I returned to the UK to continue my training schedule.

The next phase in my training was water survival at Plymouth. This was also very similar to my USAF training, a bit of academics followed by the practical application – getting in the water! Parasailing off a boat, getting in a dinghy and being picked up by a rescue helicopter was actually fun, although I must say the English Channel is a bit colder than Biscayne Bay in South Florida!

VERTICAL FLIGHT – IN THE GAZELLE

From Plymouth, I headed up to RAF Shawbury for the Gazelle Helicopter Short Course. This was a three-flight, six-hour course designed to give us an introduction to vertical take-off and landing (VTOL) and hovering that we would experience with the Harrier. This was also a fun bit of training in which we were not required to learn a lot of systems or emergency procedures. We had about an hour of academics followed by flying with an instructor to a series of 'hides' in the woods. There we worked on getting into a steady hover by picking out a tree (or other marker) located straight in front of us, and another 90 degrees off to either side.

Once we 'mastered' the hover, we practised going straight up to a steady hover and going straight down to a landing. This took a bit of practice getting used to using the right amount of power (collective) and control inputs (cyclic). By the third flight we were having fun chasing sheep around meadows and dropping into various hides in the local area. At the end of the entire year of training, we all agreed that this course was vital in learning the 'ups and downs' of VTOL and that it was one of the most fun.

Then it was back to Wittering to begin training in the Harrier. Or, so I thought. When Wing Commander Pete Day stopped by our house that Friday night, my wife and I were somewhat surprised. He was the 'Boss' of the 233 OCU (Operational Conversion Unit). Over a Michelob he explained that since my slight break in training (with my dad's death) and my less than stellar performance at Brawdy, it had been decided to give me a bit more Hawk flying to get me fully up to speed in the low-level nav arena before I would begin the Harrier course. Since low-level flying would be the major emphasis in the Harrier, it would be best to get it down pat before progressing on. Instead of beginning Harrier training in July, I would go to RAF Chivenor first and then begin the Harrier course in August. Although disappointed, I knew he was right and that I needed some more work on flying low and fast.

So it was off to south west England to RAF Chivenor, another Hawk training base. There the training concentrated on low-level navigation and getting my brain and eyes geared farther ahead of my flight path. Just like at Brawdy, I flew with a great bunch of instructors and even got a few back-seat 'sandbag' flights to watch and see how they did it. I began to get the hang of it and gained some much-needed self-confidence. The countryside in Wales and southwest England was beautiful, and we had fairly free range of space to fly in, i.e. valleys and meadows, with quaint villages which we tried hard not to overfly. Now I was ready to move on to the Harrier! ➤

“I WAS FAIRLY LIGHTWEIGHT, AND THE AIRCRAFT SPUN AROUND LIKE A TOP IN WHAT SEEMED LIKE A SPLIT SECOND. NOW I WAS FACING EAST – OPPOSITE THE LANDING DIRECTION.”

In full AR5 chemical gear in the field. **Steve Deaux**

ON TO THE HARRIER WITH 233 OCU

Back at Wittering, I began the seven-month Harrier course along with two ‘ab initio’ RAF students, Dan Griffiths and Rick Hodge, both young Flt Lts. We also had two Royal Navy students who did just the first portion of the course before heading down to Yeovilton to fly the Sea Harrier. First came B (for Basic) Flight, led by Sqn Ldr Paul Warren Wilson, better known as ‘Wibbly-Wobbly’. We had a week or so of ground school, followed by a few simulator rides. We were each given our ‘tri-graph’ nicknames or callsigns. Mine was ‘Dil’, courtesy of one of my older brother’s USAF F-4 squadron mates. Suffice it to say that the more you try to fight a callsign the more it sticks. So, unflattering as it was, I was Dil.

Next came our first flights in the two-seater T.4 Harrier with an instructor in the back seat. Then we got to go solo in the GR.3 and practice normal circuits and landings. Next came another dual ride in the T.4 where the instructor demoed vertical take-offs (VTOs) and landings (VLs) and let us practice a few. Our fifth flight was a solo practising VTOs and VLs with our instructor watching and filming our initial solo hovers.

That Friday night we all went to the Officers’ Mess where we did the traditional ‘Hover Pot’. This tradition goes back to the original Harrier pilots and is celebrated with a large pewter mug filled with the pilot’s choice of beverage. Mine was the local lager.

We each said a toast and drank the full mug (two and a half pints I think) without letting the mug leave our lips until we were finished, then triumphantly held the inverted mug over our heads. My main goal was to finish, not hurl or otherwise embarrass myself. I finished in about two minutes. One of the RN guys drank Guinness and downed the whole thing in something like 17 seconds. He did, however, rush out of the bar where he promptly vacated the contents of his stomach in equally short order. So I didn’t feel too bad about being the slow poke!

We spent the next three months learning the various take-offs and landings in the VSTOL environment on B Flight. One noteworthy sortie was on my CX 9 flight. On this particular flight I was briefed to take off, fly around the circuit, decelerate down the runway, translate over to the concrete pads, and then land vertically. Mind you, this was my fifth solo flight in the GR.3 and we were not yet allowed to use the braking stop on the nozzles, only the hover stop.

For those unfamiliar, the nozzle lever, which is located next to the throttle, has a couple of blocks which are used to stop the lever at the desired position for a particular manoeuvre. As the lever is moved aft, the nozzles rotate from straight aft (normal flight) to the first stop for the hover, which points the nozzles straight down Get borne flight), and then over a guard to the braking stop, which points the nozzles slightly forward (approximately six degrees) for rapid deceleration.

Short take-off (STO) at Eberhard. **Steve Deaux**

So, on my first decel, as I came up initial on Runway 26 at about 1000 feet and 300 knots, I began to pull the nozzle lever aft towards the hover stop and added a bit of power. There was a slight tailwind and I misjudged my decel point and recognised that I was overshooting my desired hover point, and that the hover pad was going aft of my 3 o'clock position. I subconsciously started adding right rudder in an attempt to steer towards the pad as I decelerated, so much so as to completely pass through the 'rudder shaker', which is designed to keep the pilot from doing just what I was doing! This put the aircraft 'out of wind', and I performed a very rapid flat spin of approximately 540 degrees.

What saved me was that I'd remembered what we had been told in academics: pretend there is a string from your left (nozzle) hand and your right (stick) hand. When you take some nozzle, you have to give up some stick (angle of attack or back stick pressure). So, as I increased the nozzles, I relaxed back pressure. I was fairly lightweight, and the aircraft spun around like a top in what seemed like a split second. Now I was facing east – opposite the landing direction.

Gwen Richardson, my instructor in the tower, said sarcastically: "That was pretty cool! Why don't you just RVL opposite direction?" I sheepishly responded "Roger". Then I did a fairly sloppy rolling vertical landing (RVL) on Runway 08 and taxied clear.

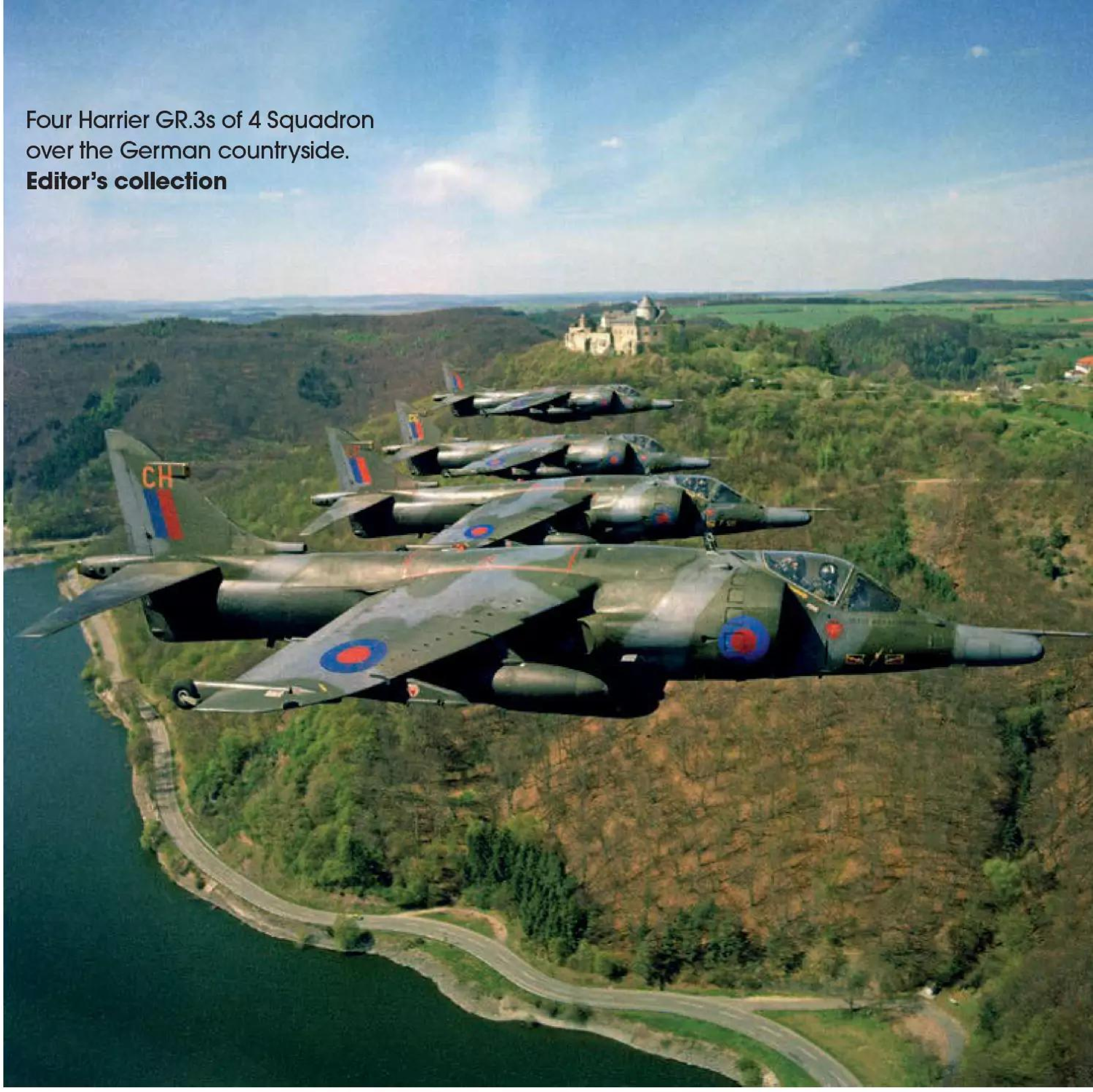
Gwen then said: "So, do you want to try that again?" I'm thinking: "You've gotta be kidding me!" But after a few deep breaths, I responded in my most professional voice: "Roger!"

I lined up on Runway 26, went back around the circuit, did another decel, starting much earlier and more cautiously this time, came to a hover over the runway, translated over to the concrete pads and performed a nearly flawless vertical landing.

By now I was low on gas, so I taxied in and shut down, whereupon I was swiftly met by my instructor, Flt Lt Andy 'KP' Kirkpatrick, who said: "Well done, Dil, why don't you take the rest of the day off? Go home, kiss the wife." I guess he could tell by my pale, sheepish grin that I was a bit shaken.

Later, I'd found out the guys in the squadron were watching from the kitchen window and nearly spit out their tea as they watched my buffoonery. I also found out that this manoeuvre was affectionately known as a 'twizzle' and had been part of the airshow display sequence several years previously, but had been outlawed because it was so dangerous! I was also told that another pilot had many years earlier done a similar trick, also inadvertently, and ended the manoeuvre scooting between two hangars at about 50 feet and 90 degrees from the runway. So, I figured, well at least I hadn't done that. I did repeat CX9 the next day, this time without the twizzle.

The rest of B Flight consisted of more VSIDL practice, formation, instrument and BFM sorties. When we finished B Course, they showed us 'The Crash Film'. This was a compilation of various Harrier crashes, from early test hops, RAF and USMC students, and other sundry accidents. One particularly memorable one was from an early Marine student with his instructor yelling on the radio: "Power Larry, ... nozzles Larry, ... EJECT LARRY!" followed by Larry's ejection and subsequent crash of the aircraft. They waited until we were finished with B Flight before letting us see this film so as not to scare us into quitting. Now we were ready to move on to A (Advanced) Flight which was led by Sqn Ldr Chris 'Boggy' Moran.


Four Harrier GR.3s of 4 Squadron over the German countryside. **Editor's collection**

On a solo flight above the clouds in 233 OCU Harrier T.4. **Steve Deaux**

WEAPONS AND RECONNAISSANCE TRAINING

A flight began with basic weapons delivery academics and then sorties to nearby Holbeach Range. I felt reasonably comfortable dropping practice bombs and shooting rockets, and got fairly good scores at the range. I did find the Harrier's ADEN 30mm guns to be more difficult to score well with than the A-10's newer GAU-8. I had been a fairly good strafer in the A-10, but was not able to get good hits with the Harrier guns. You had to press into minimum range, squeeze the trigger and then pull hard off target so as not to 'frag' yourself on the recovery. ➤

Combat ready toast with Wing Commander Gault. **Steve Deaux**

Harrier in a hide. **Editor's collection**

One particular solo range ride I had very good bomb scores, several 'DHs' (direct hits – or 'shacks' in USAF lingo). I told the guys in the range tower that I owed them beers for the good scores. So that weekend I took my wife and son on a little sightseeing trip to East Anglia and The Wash where Holbeach was located. I took the range guys a couple of cases of American beer, Budweiser and Michelob I think. Every subsequent flight I had to Holbeach, I had nearly all DHs. It pays to take care of the guys.

We also did reconnaissance sorties on A Flight, which was challenging, but rewarding to get back from a flight and walk over to the RIC (Reconnaissance Intelligence Centre) and see the photographic results. With the nose camera and centreline pod with five cameras, we could practise on point targets such as towers, armoured vehicles or bridges, or do line searches for targets such as roads or lines of communications. This would be a very important part of our mission on 4 (AC or Army Co-operation) Squadron.

Training progressed along and soon it was time for the graduation exercise, where we deployed to RAF Linton and did simulated operational combat sorties. This was time to put everything together that I had learned and put bombs on target. We flew low level nav up to Spadeadam Range and then to another of the ranges for a bomb delivery. These were flown as lead of a two-ship formation with some of the flights 'bounced' by another instructor. We put a lot of planning into the routes we flew, taking into account simulated threats, terrain, weather etc.

I had bad luck on my first sortie with a malfunctioning bomb pod and had to bring all my bombs home. My next couple of flights went well up until the critical bomb delivery at the range. When acquiring the target late and being a bit lower than the planned 100 feet, I released late sending my bombs well long of the target, twice.

Now the pressure was on for my last flight. I had to get a 'hit' or else I might not pass the course. To add even more pressure, I was leading The Boss, Wg Cdr Day! All went well until – you guessed it – all my bombs hung up again, and I didn't get any to drop. We got back to Ops and looked at the film, and sure enough, I had flown good parameters on speed and altitude, hit the 'pickle button' right on target to get a hit, but due to the malfunctioning bomb pod, no luck. So thankfully, I passed anyway – although I hadn't hit England on any of the bomb runs! Thank you, Lord!

At the graduation ceremony back at Wittering, Dan and I were thankful to still be there as Rick had earlier been sent off to fly Tornados, and previous courses had seen several good pilots 'chopped' and sent to other postings. Since both of us had had 'interesting' VSTOL excursions, we weren't surprised when The Boss told us there wouldn't be a VSTOL Award for our class. I was pleased to win the Recce Award, but not surprised that Dan had won the Bombing Award. I was just proud that we had both made it through a very demanding programme and not bent any airplanes – or hurt ourselves – in the process. ➤

ARMED

OPERATIONAL WITH 4 SQUADRON

Now it was on to Gutersloh for the real mission of operational flying on Number 4 (AC) Squadron. One of my first flights there was a local area familiarisation ride to get acquainted with the low fly areas and terrain. Gutersloh was located in the North German plain with mostly flat terrain to the north, industrial cities of Essen and Dusseldorf to the west, hilly and mountainous terrain of Bavaria to the south and East Germany only about 40 miles east. Gutersloh had two Harrier squadrons and two helicopter squadrons, one with Chinooks and the other Pumas. This was the cold war era, so we trained hard to be ready for the big Soviet and Eastern Bloc threat. Much of our day-today tasking on 4 was in support of the Royal Army in the form of armed reconnaissance, and we practised taking photos of targets all over Northern Germany.

A typical day would start with the Met (meteorology) brief by the Squadron 'Auth' (authorising officer), who was an experienced squadron pilot in charge of the day's flying. Then we would have 'AFV', armoured fighting vehicle recce, where the Ground Liaison Officer (GLO) would show slides of various vehicles, tanks or aircraft, and we would go around the room identifying them. The GLO would also brief us on the day's intelligence and threat scenario. Then we would break up to plan and brief our morning sorties.

These would vary from a four-ship low-level strike (SAP) mission to two- and four-ship weapons flights to Nordhorn Range or a solo recce mission or instrument sortie. SAP missions usually began south of Gutersloh at the Mohnesee, then into the hills and valleys to the south and east, and often came close to the Inner German Border (IGB) for a simulated target run. Range sorties usually consisted of 100ft level bomb deliveries using 3kg practice bombs, simulating high-drag 1000lb bombs, followed by low-angle strafe passes.

We also practised air-to-air refuelling with VC-10 and Victor tankers. 'Jousting' with the 'basket' (refuelling hose with a mesh metal fitting) was initially a challenge as it seemed to always move right at the last second. With practice it became easier. Another new air-toair experience was 1-v-1-v-1 with three Harriers where each was pitted against the other two. Just when you were about to 'saddle up' on one guy, the other would be closing in on you! Then it was time for a bit of 'viffing' (short for vectoring in forward flight). Sqn Leader Harry Karl and Gary Pheasant were two of the best in the squadron at air-toair and I learned a lot from both of them.

It wasn't long before we started preparing for my first field deployment. This was where both 3 and 4 Squadrons packed up and flew to various sites in the surrounding area and operated on a wartime footing with support from the Royal Engineers and local German authorities. We did this three times a year, usually in the late spring, then mid-summer and again in the early fall, for two weeks at a time. Each squadron divided up into three sites with between four to six aircraft, six to eight pilots and enough support personnel to carry out simulated war-time tasking. The ground support folk drove out in trucks and brought fuel, spare parts, mess facilities, and tons of supplies.

Repacking my kit in the field.
Steve Deaux

My first site was Eberhard in the Sennelage Tank Range which was an army manoeuvre area just south-east of Gutersloh. It was amazing to see what seemed like a huge logistical maze come together in such a short amount of time and run so smoothly.

LIFE IN THE FIELD

We lived in tents and slept on cots, took 'field baths' out of a basin and pretty much roughed it for two weeks at a time. We did eat three hot meals a day, thanks to the cooks and mess staff, which really beat the Meals Ready to Eat (MREs) and other rations I had usually experienced during war games. Occasionally we would sneak off the site to get a real shower and even a pint of lager at the local army mess. Once, after returning from one of these shower runs, as we approached the security checkpoint, the guard said "Halt! What's the password?" To which one of my mates responded: "Piss off, we're the pilots!" "Sounds like a valid password to me," the guard replied, "come on in."

Aside from these occasional excursions, we worked hard on these deployments. We flew up to six flights a day – which was unheard of in my USAF experience. I'd flown three flights a day in the A-10 during exercises, and though they were usually longer sorties, they were never as demanding or task saturating as these Harrier field sorties. We flew some sorties in full chemical gear, which was pretty hot in the late summer months. We also demonstrated our ability to pack up and move sites on occasion which was especially challenging for all the ground troops. They were remarkably capable and flexible performing maintenance and supporting the mission, even changing engines in the hides.

We operated out of camouflaged hides which made the sites virtually invisible from the air. We would climb in our jets, brief via a 'telebrief' cord, start up and taxi out of the hides and do a short take-off (STO) from a two-lane country road, or 800ft-long 'tin strip' of perforated steel planking (PSP) or even on a grass strip, 'clean up' (raise the gear and flaps) and nozzle away as we climbed above the trees to 250ft. After take-off we would fly to the rendezvous point (RV) which was oftentimes the Hamm chimneys (factories south-west of Gutersloh) and then press on to the target.

We did most of these missions comm-out, or at least with a minimum of radio calls, using hand signals and standard operating procedures (SOP). We would fly the low-level route at 250 feet, drop down to 100 feet for the attack, 'drop' our simulated ordnance, jink off target, rejoin and fly back in tactical formation, watching out all the while for bandits and simulated ground threats. These exercises were often NATO wide, and we would routinely see and even be 'bounced' by American F-15s, German F-4s, Dutch F-16s, French Mirages, Canadian CF-18s or British Tornados.

Heading to Nordhorn Range in a GR.3 with squadron colours tail flash. **Steve Deaux**

As we made our way back towards the site, we would take spacing, do an IP-to-target run towards the pad, decel and land vertically, then taxi back into the hides. Once in the hide, the ground guys would refuel and rearm us so we could brief up and go fly again.

On recce sorties we would do much the same thing, but instead of attacking the targets, we took photos. Back on the ground, a chap would ride up to the aircraft, pick up the film, ride back to the field RIC, process the film, then bring the photos back to the pilots for pre-mission study.

The next sorties would be to attack the very same targets that an hour before we'd taken photos of. Pretty cool!

DEPLOYING AND SOCIALISING

Usually on the Saturday night of the deployment, the officers would go to a local German restaurant or, if that wasn't available, an on-site mess tent for a 'Field Dining Out'. This was a long-held tradition, where we would have a nice meal complete with wine for toasts, followed by skits or 'choir practice', and finally by The Boss's speech.

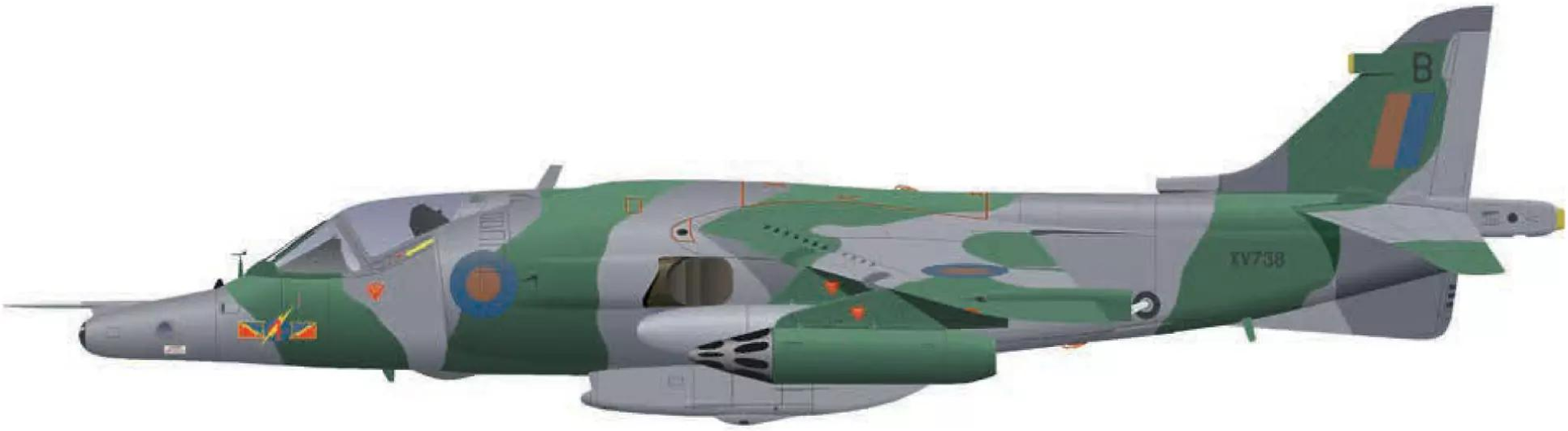
Another long-held tradition was for the newest member (FNG) to write said speech the morning of the dinner for The Boss to read, verbatim, that night. Since I was the 'New Guy', it was up to me to come up with an appropriate speech complete with as many bawdy jokes as I could possibly come up with. I was led to believe by my mates that I couldn't make it – the speech – too vulgar and that I should just go for it. Being forewarned about this tradition, I brought along a book of gross Jokes my brother had sent me. It was filled with some of the foulest humour I had ever seen, but was again reassured that this speech was no holds barred. So, not wanting to be outdone, I proceeded to write a truly disgusting speech, filled with bathroom humour, perverted sex jokes, you name it, this speech contained it.

So that night after a good meal of schnitzel, kartoffeln and apfel struedel, we settled back awaiting the Boss's speech. Wg Cdr Roger Gault was also fairly new on the squadron, a very professional and polished leader who unfortunately I hadn't got to know very well yet, but I was soon to find out that this speech was not his cup of tea. I could've just included a couple of not-so naughty jokes or some silly American puns, but NO, I went for it – the whole enchilada!

He began the speech and got just past the first few words, paused and looked up at me as I tried to hide, and looked back at the words I had written. At which the boys yelled: "You've gotta read it Boss! All of it!" He looked back down, started reading again, growing ever redder as he read, followed by howls of laughter from the boys. You could hardly hear most of it over the peals of laughter and guys slapping me on the back and pounding the tables. The boys loved it. The Boss hated it. As we headed back to the site, Sqn Ldr Glen Edge told me: "Dil, that was the best one ever!" It would take a while before I could look The Boss in the eye, but I hoped he would forgive me, and I think he did after getting to know me better.

These field deployments were definitely a highlight of the exchange tour. Another of the highlights for me was our month-long deployment to Decimomannu, Sardinia. There, we flew Dissimilar Air Combat Training (DACI) sorties against RAF Tornados, USAF F-15s and Dutch F-16s on the Air Combat Manoeuvring Instrumentation (ACMO Range. This training with pilots from different countries and services was invaluable in building air-to-air skills, developing tactics and exchanging ideas.

➤



A Harrier GR.3 of 4 (AC) Squadron. **Keith Draycott**

Left: Taxiing out of the hide in the field. **Steve Deaux**

BRITISH AEROSPACE
V/STOL HARRIER
500+ HOURS

Below: The 500-hour patch. **Steve Deaux**

On Friday nights we also shared our hospitality with the other services at the affectionately named Pig and Tape Bar at the RAF Mess. One particular night the Dutch guys came over, and we began telling jokes and singing songs. Before you knew it, we had a huge bonfire of burning boxes out in the patio grill. Our Italian hosts were not very happy with us though, so we toned it down a bit after that night. We also flew weapons delivery sorties to Capo Frasca bombing range where we practised new dive bomb deliveries as well as the standard level bombs and strafe. One weekend we took four jets cross-country to Pisa and visited the museums in Florence, and of course ate a lot of pasta and sampled a bit of good wine. Molto bene!

> "I GREW TO HAVE A HEALTHY RESPECT FOR THE JET, THE ENVIRONMENT IN WHICH WE OPERATED AND FOR MY FELLOW PILOTS."

Another notable deployment was an Operational Low Flying Detachment to RAF Lossiemouth, Scotland, for my 100ft lowlevel flight lead checkout, where we were bounced by Canadian CF-18s. This was good aggressive low flying in beautiful terrain with the famous lochs and mountains. We made good friends with the Canadian pilots and they invited us down to their home base of Baden Soellingen in south-western Germany for a week's worth of flying. While there, I got a back seat CF-18 flight with my old Air Force Academy classmate and pilot training buddy, Paul Bordenave, who was also on an Exchange tour.

I received my 500-Hour Harrier badge there after a particularly exciting sortie where I hit a turkey vulture at 420 knots and nearly lost my engine. He, the vulture, put a hole bigger than my helmet in the left intake outboard edge. I made it back to Baden Soellingen with my Flt Commander, Sqn Ldr 'Dez' Dezonie, where I was awarded my badge and instructed not to hit any more birds!

Yet another notable deployment was to Fassberg for Operation Treaty where we flew sorties in defence of the Berlin Corridor. This was another international exercise with RAF Harriers, USAF A-10s and French Mirages. The flying was good, and every evening a different service hosted a national-themed dinner. The first were the Germans with bratwursts, sauerkraut and German beer. Next came the Americans with hamburgers, hotdogs and American beer. Then it was the Brits' turn, so we had fish and chips and English beer. I can't remember what the French dinner was, but I'm sure it included wine and cheese. I did, however, carry on an old tradition of trading flight suits with another service's pilot. I ended up with an extra long French flight suit which wasn't as bad as my tall French friend who ended up with a 'high water' (much too short) version of the American suit.

Such a discussion of my experiences as an Exchange Officer would not be complete if I didn't mention the many social functions we were involved with, from formal dinings-in to summer balls to squadron parties to almost weekly 'hospitality checks'. These were all fun and usually included alcohol. I'm pretty sure I lost a few brain cells during this time frame. Invariably, they included singing old fighter pilot songs, and a few ended in rowdy games such as 'crud' or mess rugby. Only once did I witness the old tradition of burning the piano, and luckily no one was injured in the process.

Another tradition we upheld was the annual Fourth of July Party complete with hotdogs, hamburgers, watermelon, a pieeating contest, softball, fireworks, a disco, and of course American beer! We even had a little band called The Chance Brothers who would play on deployments and parties. I was Fat Chance, rhythm guitar and bartender. We had Slim Chance on vocals and guitar, No Chance on lead guitar and our drummer was Arthur, Halfa Chance. We weren't very good musicians but we had fun and we helped keep morale high.

These fun times were interspersed with some very sad times as we were often reminded of the seriousness of our profession. During my tour, we lost four pilots and six jets due to various factors. The GR.3, though very capable as an attack fighter, was difficult to fly and unforgiving of any inattention or misstep. I grew to have a healthy respect for the jet, the environment in which we operated and for my fellow pilots. It was a small but very close-knit fraternity and I was proud to have been a part of it and in such a historic time.

Shortly before we left, we witnessed the fall of the Berlin Wall and the beginning of the collapse of the Soviet Union. Times were changing and so was the Harrier Force. My replacement, Larry Ching, would get to fly the new GR.5 and see the reduction of low flying in Germany due to noise complaints. I returned to the states for a staff tour at Langley AFB, VA, and then returned to the A-10. I thoroughly enjoyed my entire career, flying all over the world with some incredible pilots, but the highlight still remains my time as a Yank in Her Majesty's Service. ■

Words: Steve Deaux

Brit/Yank Lexicon

When I found out I'd be flying Harriers with the RAF, I thought at least I won't have to go to language school like a friend who was going to Germany on an exchange tour with the Luftwaffe. How naive I was.

Of course I knew about driving on the ‘wrong’ side of the road and the different voltage for electronics, but I didn't think I'd have to learn a new language!

I loved Monty Python and Benny Hill and was pretty good with an English accent (“What accent? You Yanks have the accent!”).

When our six-year-old son came home from his first day of school and told us he needed a rubber, my wife screamed, “What are they teaching these kids?!” We found out what he needed was an eraser. And when she told him once at a restaurant, that if he didn't sit down she would spank his fanny, we got lots of strange looks from other diners.

In my first flight briefing the instructor said things like “Bob's your uncle,” you'll be “quids in” and “tickety-boo!” as he explained what we would do in the air. By the end of the briefing I was still thinking, I don't have an Uncle Bob! I knew then I'd have to work hard to communicate in our new home. As the old saying goes, we are “ ... two countries separated by a common language”.

With regional accents, Cockney rhyming slang, military phrases and jargon, there are a lot of differences, so I have compiled a list of words and phrases that have slightly different meanings depending on whether you are British or American. Some are military terms and others are used in everyday speech. Some are even humorous! ➤

A

Aluminium has an extra ‘i’ and is pronounced al-you-min-eee-yum
‘A to Zed’ is the same as ‘A to Zee’
Altimeter is pronounced: al-tim-EAT-er
Ale is beer

B

Boot is the trunk and bonnet is not a lady's hat
Bog is a commode or toilet
‘Bob's your uncle’ is an expression for ‘there you have it’
Bobby is a cop
Braces are suspenders, not teeth straighteners
Biro is an ink pen
Bloody is an adjective (as in Where's my bloody biro?)
Bin is a trash can
Bitter is a type of beer (as in I'll have a pint of bitter please)

C

Chips are French fries and crisps are chips
A **cooker** is a stove
Cello tape is Scotch tape
CV is one's curriculum vitae or resume
Cricket is a game not an insect
Cheers is not just a toast (or TV show)

D

Dole is welfare and not a brand of pineapple

Dosh is money

‘Dog & bone’ is Cockney for telephone

Double is a stiff drink (2/6th of a gill) and preferably served ‘neat’

E

England is part of Great Britain

F

Flat is an apartment

Fag is a cigarette

‘Fanny’ is a very naughty part of the anatomy – not your bottom!

G

Gobsmacked is to be astonished

Gordon Bennett! is an exclamation

Guy Fawkes tried to blow up Parliament (which calls for a great party in November)

Git and **Geezer** are not very nice names to call someone

Garden is one's yard

Glaswegian kiss is an aggressive greeting (headbutt)

H

Hoover is to vacuum

Hols is short for holiday

‘In hospital’ as opposed to ‘in THE hospital’

‘Ome is where ‘arry ‘angs ‘is ‘at! (H is sometimes silent)

Haggis is something you eat at a (Robbie) Burns Night (along with drinking a lot of Scotch!)

I

IPA or India Pale Ale is also beer. Lots of words for beer in England

J

Jam is jelly

Jelly is JELLO

Jumper is a sweater (as in woolly jumper)

Jump Jet is a Harrier

Jolly good is a jolly good saying!

K

Knickers are women's underwear

'Knock me up in the morning, love' is a request for a wakeup call

Kiwi is a New Zealander – not the fruit

Knackered is exhausted or tired

Kip is a nap

Kit is your stuff

L

Limey is a not so nice name for a Brit

Loo is a bathroom

Lorry is a truck

Lift is an elevator

Local is one's neighbourhood pub (as in 'let's pop down to the local for a pint')

M

Mate is a buddy

Mum is Mom

Mexe pad is a place to VL a Harrier

'Muckin' about' is the same as 'messin' around' (as in I was muckin about wiv me mud-movin' mates)

Motorway is freeway and the M1 is one of the main thoroughfares in England – not a tank

N

Nosh is to eat or munch

Neeps and tatties are turnips and potatoes

Nick is to steal

NAAFI is a BX or Base Exchange store

Nappy is a diaper

N.B. means to pay close attention (nota bene)

O

Orientate (as in I was temporarily disorientated)

Off Licence is a liquor store

P

Pissed is to be drunk (not to be confused with 'pissed off' or angry)

Port is both a direction and a drink

Pound is a unit of money – not weight

Pants are underwear

Potty is crazy

PD is a practice divert

Pub crawl is bar hopping

'Practice Pan, Practice Pan, Practice Pan' is a radio call heard often when student training is in progress

Petrol is gas

Pudding is dessert

Pukka gen is 'the gouge' or good intel as opposed to duff gen

Pram is a baby carriage

Puff is something a Yank does to a cigarette (fag)

Q

Quid is a pound sterling (as in 'quids in' or 'that'll be 10 quid')

R

Roundabout is a traffic circle

Rotate is cross-turn

Right! is the start of every briefing

Randy is an American name

Roger is another American name

RV is to rejoin a flight (as in rendezvous point)

Roller is a touch-and-go landing

Rubber is an eraser

(be made) **Redundant** is to get laid-off from work

Rubbish is garbage

S

Starboard is right

Shag is not a type of carpet

Sod off is not nice

Suss out (to have it sussed) is to figure it out

Sarnie is a sandwich

Skew-whiff is not quite right

Skip is a Dempsey Dumpster

Spanner is a wrench

Stone is a unit of weight ('Blimey I put on a stone on hols!')

Spitting is groovy (as in 'have a spitting day!')

Suspenders are garters

Scotch is a drink, preferably single malt (don't call a Scotsman Scotch! You might get a Glaswegian kiss!)

T

Turn about (port/starboard) is a hook or 180° turn

Taking the Mickey/piss (as in 'Are you takin' the Mickey?') is kidding or pulling one's leg

Tea is a beverage and a meal

Take away is take out (food)

Tannoy is a loudspeaker or announcement

Tenner is a 10 pound note

Tins are cans

Ta is thanks

U

Undercarriage is an aircraft's landing gear

V

Viff is vectoring in forward flight

VL is a vertical landing

VSTOL is vertical and short take-off and landing

W

Wellies (Wellingtons) are boots

What! (as in I say, what?) is an old expression

Wanker is another not so nice thing to call someone (as in 'sod off you wanker!')

Wadi bash is flying low through the valleys (fun!)

X

Triple **X** is the sign of a good, strong beer, not adult movies

Y

Yobbo is a troublemaker

Z

Zed is the last letter in the alphabet

A **Zebra crossing** is a cross-walk

I know this is not an all-inclusive list, and I did not delve into many of our spelling differences: i.e. humour, colour, defence, etc. But let me close with a bit of 'Harrier speak': "Tick, V-G, awesome, god-like, had to be said, stiff upper lip, off we go!, Happy?! well above average, grab a handful of shiny lever, hover on the mexe, nod, nod, wink, wink, braking stop bow, flaps on yer boots, COPE!"

Cheers lads and ta very much indeed! ■

Words: Steve Deaux

A pair of BAE Sea Harrier FA.2s of 801 NAS while on exercise in the US. **Frank B. Mormillo**

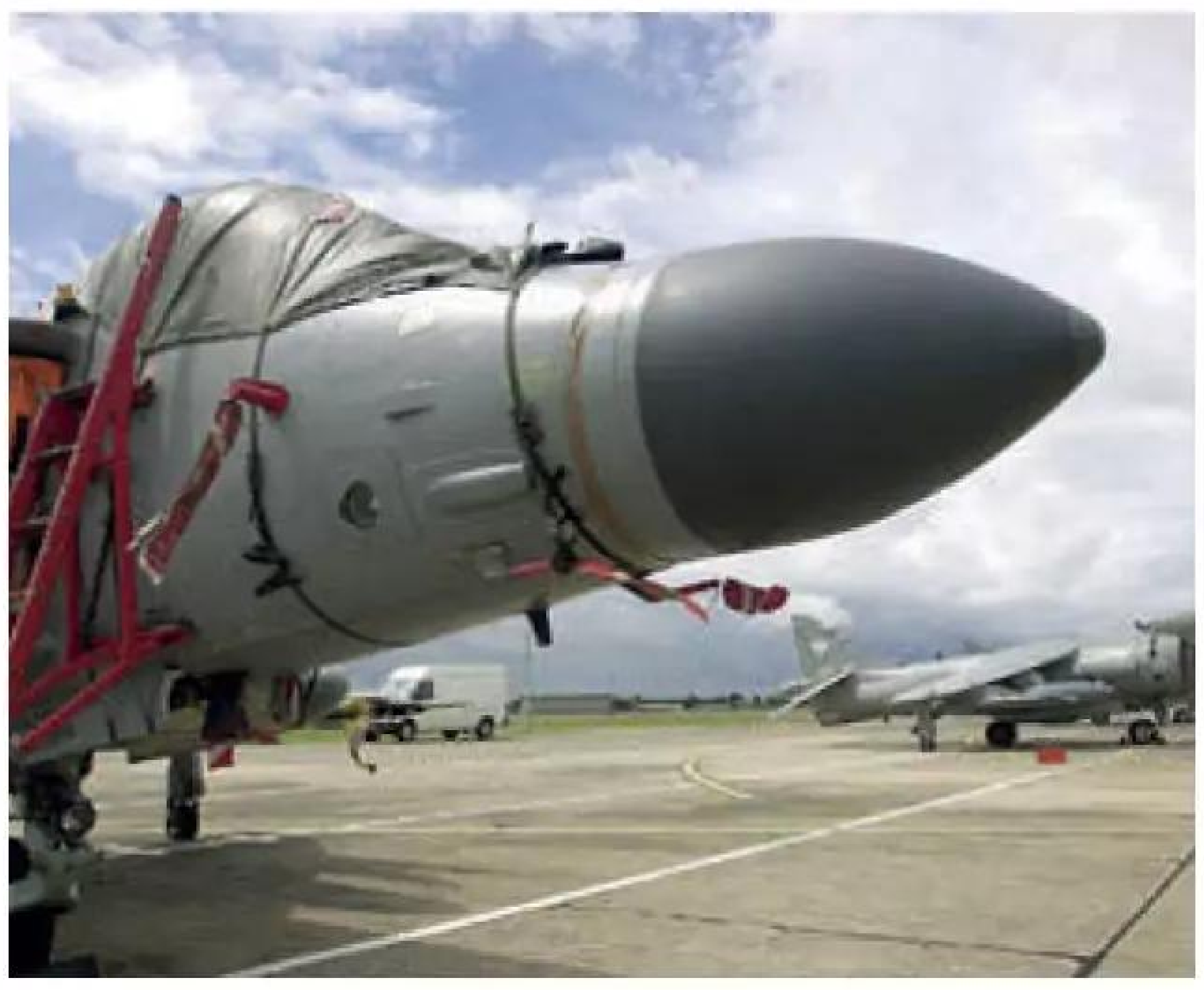
The last of the small wing Harriers

The Sea Harrier FA.2

The operational experience gained in the Falklands War and the incredible success of the Sea Harrier in the fighter role led to the last development of the original Harrier design, an aircraft celebrated as the best radar and missile fighter combination in the world when it entered service.

The main lesson learned with the Sea Harrier FRS.1 from operations over the Falklands was that its performance, radar and missile ranges and effectiveness were insufficient to protect a fleet when operating outside of airborne radar cover.

The lack of an airborne radar and control system meant that too many Argentine attacks got through the holes in the air defence net… and each time ships were damaged or lost. If one the aircraft carriers had been lost prior to the landing on the islands, then the Falklands War may have had a very different ending.


The large radome of the Blue Vixen radar gave the BAE Sea Harrier FA.2 a distinctive look. **Joe Walsh**

Since no UK fixed wing fleet carriers capable of operating an airborne radar aircraft were available, the Sea Harrier itself became the subject of an upgrade that was to enormously increase the power and effectiveness of the radar and to increase the range of the Sea Harrier's main weapon from 11 miles (18 km) to over 50 miles (80 km).

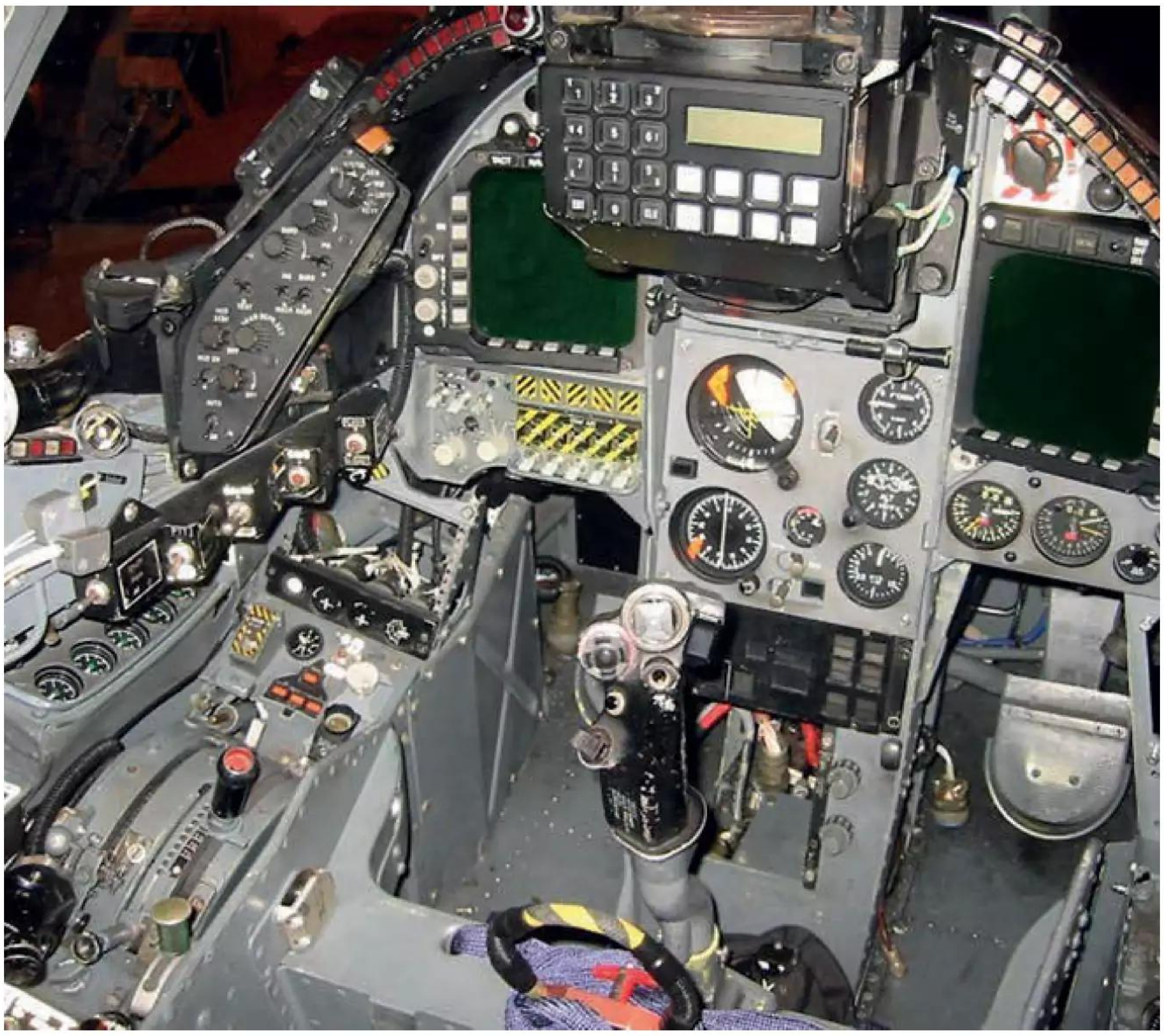
The original proposal to upgrade the Sea Harrier significantly came from British Aerospace in 1983 in the light of the data coming out of the Falklands War. Since there was only a limited budget for naval aircraft, it was an upgrade that was proposed rather than a new design. This proposal was to re-engine the aircraft with the improved Rolls-Royce Pegasus 11 Mk 106 which produced 21,500lb (9752 kg) of thrust, and to change the Blue Fox radar for the Blue Vixen.

The Blue Fox had been a derivative of the Sea Spray helicopter radar and was able to operate in the dual role of airborne interception and air-to-surface search and strike. As such, it was a good lightweight solution, but simply lacked the power, range and, most importantly, ability to handle multiple targets that was now seen as a requirement. The Blue Vixen was a quantum leap forward by comparison, a lightweight multi-mode, coherent, pulse Doppler airborne interception radar operating in the I-band and weighing only 320lb (145kg) with a range of 95 miles (150km). It was a true multi-mode radar, with all-weather operation in look-down and look-up modes and over-sea and over-land detection of targets. It also incorporated high-resolution ranging in air-to-air as well as its land and sea search modes and was designed from the outset to operate with the Hughes AIM-120 AMRAAM.

At the time of its introduction, Blue Vixen was one of the most advanced pulse Doppler radar systems in the world, and it was used as the development basis for the Eurofighter Typhoon's current CAPTOR radar system.

The weapons available to the Sea Harrier were also upgraded, the most significant being that already mentioned, the AIM-120. Known as the Slammer, the AIM-120 gave the new Sea Harrier proposal nearly four times the weapon range of the FRS.1. It also introduced beyond visual range (BVR) capability to the aircraft, as well as the ability, in conjunction with the Blue Vixen radar, to engage four targets simultaneously.

The AIM-120 uses a datalink from the firing aircraft for initial guidance, then switches on its own radar for the terminal guidance phase. If the target aircraft tries to jam the missiles' active radar, the AIM-120 can then switch to home-on-jam mode, passively homing onto the jamming signals from the target. The missile ➤



The cockpit of the BAE Sea Harrier FA.2, showing the head-down displays on which radar and navigation information can be displayed in different formats. **BAE SYSTEMS**

A BAE Sea Harrier FA.2 of 801 NAS at an airshow, carrying two AIM-120 AMRAAMs under the fuselage and twin AIM-9 Sidewinder mounts under the wings. **Keith Draycott**

Looking at the rear fuselage of a BAE Sea Harrier FA.2, showing the extension from the FRS.1. The rear fuselage extension was not achieved adding a plug, but by building completely new rear fuselages to maintain strength. **Joe Walsh**

For ferry flying or long-distance operations, the BAE Sea Harrier FA.2 can be fitted with a fixed air refuelling probe. **Joe Walsh**

A BAE Sea Harrier FA.2 of 801 NAS at RAF Waddington on Exercise Nomad 2004. **Joe Walsh**

is also extremely manoeuvrable, all of which means it is very likely to hit what it is aimed at. It first entered service with the US Air Force in 1991 and continues in both development and service today.

The BAE Sea Eagle long range sea skimming anti-ship missile added a powerful maritime punch to the proposed fighter, and it could carry a range of bombs and rockets in the strike attack role, along with the two 30mm Aden cannon for ground strafing.

Lastly, the proposal was for the new aircraft to carry the MBDA ALARM anti-radiation missile. This was in development at the time having been selected in 1983 by the MoD over the American HARM.

The missile, when launched against an enemy radar, homes on the signal from the transmitter. If the radar shuts down to avoid the missile, it climbs to an altitude of 45,000 feet (13,000m) and deploys a parachute, 'loitering' above the target radar. If the radar is switched back on, the parachute is jettisoned and the missile re-lights its motor to strike the target. Even if it misses, the effect is the same as a hit as the enemy radar is switched off for a period long enough for the 'friendly' aircraft to escape.

The cockpit was to be fitted with two new head-down displays (HDD) and a head-up display (HUD) from Smiths Industries, which was also to supply the air data computer, engine control computer, engine indicators, fuel management and gauging, air data indicators, radar indicator, stores management system, and the weapon aiming and display computer. The cockpit was also to be equipped with a Thales Optronics (Vinten) display recording system for the HDDs and HUD and a Martin-Baker Mark 10A rocket-ejection seat.

To improve survivability – another lesson of the Falklands – the new Sea Harrier was to be equipped with the BAE Systems Sky Guardian 200 radar warning receiver and the AN/ALE-40 chaff and flare dispenser from BAE Systems and Raytheon.

The AN/ALE-40 was capable of launching chaff, flares and active expendable GEN-X radar decoys. Lastly, the nose was to be fitted with an F.95 surveillance camera with a cockpit voice recorder for reconnaissance mission evaluation.

Aside from the new equipment and weapons, a number of physical modifications had to be made to the Sea Harrier to accommodate the changes. The rear fuselage was stretched by 14 inches (0.35m) to house the new electronics and provide aerodynamic balance for the much larger nose and radome required to house the Blue Vixen. The wingtips were also extended slightly, by 16.25 inches (0.4m).

A BAE Sea Harrier FA.2 of 801 NAS during Exercise Nomad at RAF Waddington in 2004. **Joe Walsh**

This mid-life upgrade package was approved in 1984, and in 1985 two development aircraft were ordered for trials and designated Sea Harrier FRS.2. These were converted from FRS.1s ZA195 and XZ497 which flew for the first time on September 19, 1988, and March 8, 1989, respectively.

To test the new radar, two BAE 125-600B executive jets, XW930 and ZF130, were modified in 1985 to carry the radar and act as an avionics suite trials aircraft for the new fighter. While the trials were continuing, the designation of the aircraft was changed to the more modern FA.2 to denote it was a fighter with attack capabilities.

With the success of the trials, a contract was signed in December 1988 to convert 29 FRS.1s to FA.2 standard. This was contract modified in 1990 to include an additional 18 new build aircraft and again, in 1994, for an additional four aircraft to be converted from FRS.1 stocks. In total 51 Sea Harrier FA.2s were built, the conversion work on the first FRS.1 airframes beginning in February 1991.

The first competed conversion, ZE965, was returned to the Royal Navy in April 1993.

While the conversions were taking place, the first two pre-production aircraft were flying service trials. In October 1990 more than 70 ski jump tests were made at Yeovilton, carrying every conceivable variation of weapon and fuel load. These trials were followed by the first operations from an aircraft carrier when both aircraft landed aboard HMS *Ark Royal* in November.

After successful deck trials, and with production underway, an Operational Evaluation Unit was formed on June 1, 1993, at Boscombe Down as an extension of the Sea Harrier training Squadron 899 NAS. The first aircraft, ZE695 and ZD616 arrived in August and the parent unit received its first aircraft at RNAS Yeovilton later the same month. The first operational squadron was 801 NAS, which received its first aircraft in October 1994, later replacing the FRS.1s of 800 NAS aboard HMS *Illustrious* off the coast of Italy.

Here, they took part in Operation Sharp Guard, flying missions to enforce a maritime blockade to economic and military sanctions against the former Yugoslavia. The FA.2s went on to take part in Operation Deny Flight and Deliberate Force in 1995, flying combat air patrol and close air support sorties as part of the NATO effort to prevent further bloodshed in Bosnia.

The Sea Harrier FA.2 was again in action in the Balkans in 1999, as part of the 78-day long NATO campaign against the Federal Republic of Yugoslavia named Operation Allied Force. The FA.2s operated from HMS *Invincible*, flying combat air patrols to keep the Yugoslavian Air Force on the ground.

In 2000, FA.2s were also deployed to Sierra Leone onboard HMS *Illustrious*, which was itself part of a Royal Navy convoy to supply and reinforce British intervention forces in the region.

A number of problems began to arise with the Sea Harrier fleet from 2001 onwards. The corrosion from salt ➤

BAE Sea Harrier FA.2s of 801 NAS and Harrier GR.7s of 3 Squadron on the deck of HMS *Ark Royal*. **BAE SYSTEMS**

HMS *Invincible* with BAE Sea Harrier FA.2s Harrier GR.7s and Sea King helicopters on the deck. **BAE SYSTEMS**

A US Marine Corps TAV-8B Harrier II in formation with the demonstration F-35B STOVL variant of the Joint Strike Fighter – the eventual replacement for the venerable Harrier. **Lockheed Martin**

A very special paint scheme for the decommissioning of 800 NAS on March 31, 2004, celebrating 25 years of Sea Harrier operations. **BAE SYSTEMS**

ROYAL NAVY
714

A BAE Sea Harrier FA.2 of 899 NAS with AIM-120 AMRAAMs on underwing pylons. **Joe Walsh**

25 Years
ROYAL NAVY
ZH 809

In 2004 BAE Sea Harrier FA.2 ZH809 was painted in the original Sea Harrier scheme to celebrate 25 years of the aircraft in Royal Navy service. **Keith Draycott**

spray had begun to affect a number of aircraft, and pilots experienced reduced engine performance in the higher ambient temperatures of regions such as the Middle East – the latter being a problem common to both the RAF and RN versions of the Harrier. This restricted the weight of payload that the Harrier could return to the carrier in vertical landings, due to the safety factors associated with aircraft land-on weights.

The RAF had already begun discussions to fit more powerful versions of the Pegasus to the GR.7 to produce the GR.7A to solve this, but the Royal Navy had a problem, the new engine simply would not fit the early Harrier airframe without a prolonged and expensive modification programme.

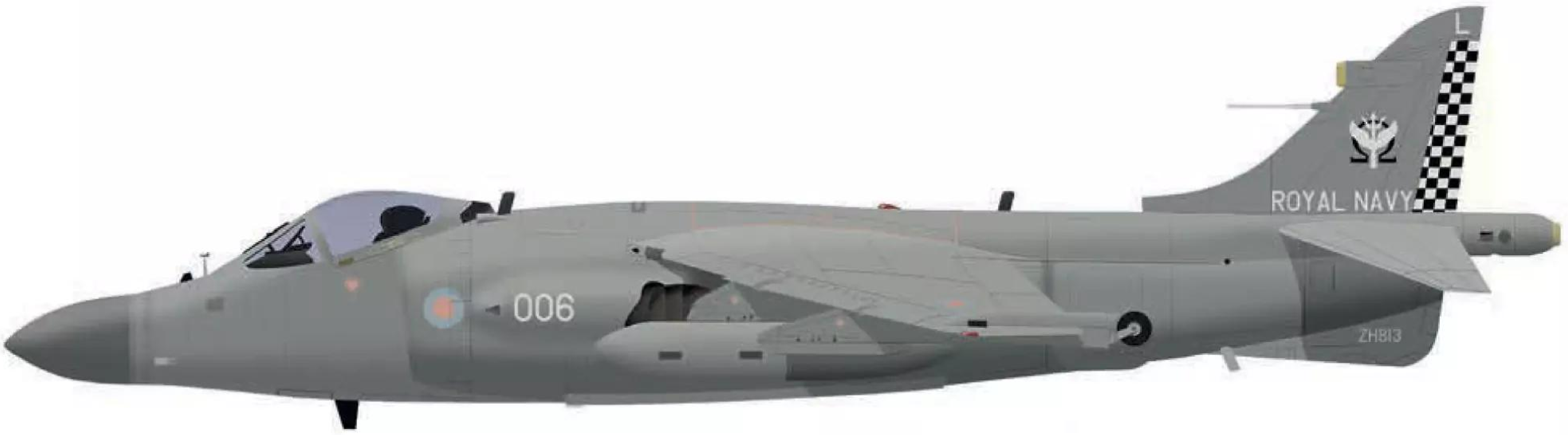
Since the Harrier's replacement, the F-35 lightning II, was intended to be in service in 2012, in February 2002, the MoD announced that the Sea Harrier FA.2s would be retired from service by April 2006, leaving a gap of only six years in capability, rather than undertake the expense of an upgrade programme.

In the interim, the combined RAF and RN Joint Force Harrier (JFH) would be operated using only RAF Harrier GR.7s and GR.9s. The first of the Royal Navy's three Sea Harrier Squadrons, 800, was decommissioned on March 31, 2004. In 2006, 3 Squadron of the RAF converted to the Typhoon from the Harrier, and its aircraft were handed over to 800 NAS who reformed at RAF Cottesmore.

The final Sea Harrier Squadron, 801 NAS, was decommissioned on March 29, 2006, recommissioning on April 6 at RAF Cottesmore on the Harrier GR.9.

The two Squadrons were reformed into a single unit, the Naval Strike Wing (NSW) on March 9, 2007, which reverted to being identified as 800 NAS on April 1, 2010. In December 2010, the entire Joint Strike Wing, as JFH was now known, was unceremoniously retired eight years early as part of the UK Government's Strategic Defence and Security Review. ■

Words: Tim Callaway



Side view of BAE Sea Harrier FA.2 ZH813 of 801 NAS. **Keith Draycott**

The big wing birds

The AV-8B and Harrier GR.5, 7 and 9

The Harrier had been a great success for the armed forces of both Britain and the US, but new military requirements demanded more of the design. Design lead in the development of the new Harrier shifted to McDonnell Douglas, and what was really a new aircraft was born.

In August 1969, Hawker Siddeley had formalised a partnership with McDonnell Douglas with a view to the latter building the US Marine Corps AV-8A in the US. The US Government insisted that all of the 110 aircraft eventually delivered were to be built in Britain, after examining the costs of developing a production line in the US and finding them prohibitive. With the Harrier GR.1 established in RAF service and the AV-8A flying with the USMC, the two companies involved in the Harrier programme had a chance consider the future of the aircraft.

In 1973, the two companies began a study to solve the two deficiencies noted in the early versions of the Harrier, payload and range. In order to solve both a larger and more powerful aircraft would be needed. At the time, Bristol Siddeley were testing a new version of the engine, the Pegasus 15. This would produce more power, but was physically bigger than earlier models of the engine and was not going to fit into the existing Harrier design. The new aircraft was given the working designation of AV-16, as it was to have twice the range and payload of its predecessor, but was officially known as the Advanced Harrier. This new aircraft was to have replaced the Harriers of the RAF and USMC, along with the Douglas A-4 Skyhawk attack aircraft then serving with the Marines. With another round of defence cuts in 1975, there was no funding available in the UK from the British Government so Hawker Siddeley pulled out of the programme in March the same year. The US Government was unwilling to foot the entire bill of development, so later in 1975 the Advanced Harrier programme was cancelled.

After this disappointing attempt at development, the two companies now began individual studies to create an advanced version of the aircraft for less of the taxpayer's money. Both kept the existing fuselage and engine as they were, rejecting the larger Pegasus variant as too expensive a place to start a new design from. Hawker Siddeley concentrated on designing a new larger wing that could simply replace the wings of existing aircraft. McDonnell Douglas began looking at the wing too, but in a different way.

One of the two YAV-8Bs built by McDonnell Douglas to test the new, larger, composite wing. **US Navy**

A vertical take-off aircraft is all about one thing: weight. The only way you can increase the payload or range of a given design and engine is to reduce the weight of the airframe to be able to carry more fuel and weapons instead. In the US, new materials were being experimented with that offered substantial weight reduction with no loss of structural strength. McDonnell Douglas proposed a new, larger wing for the Harrier, made of carbon fibre. This and other composite materials were to replace the metal structures of the Harrier where practicable, mostly in the forward fuselage and tailplane as it turned out. The design proposal for an aircraft now known as the Harrier II was given approval by the US Defence Armed Services Committee in March 1976. The USMC was delighted by this development. It had never liked the idea of a large complex aircraft like the Advanced Harrier programme had proposed. One of the things it liked most about the existing Harrier was its simplicity and therefore ease of maintenance and support in the field. Now the USMC got to keep the elements it liked about the aircraft and improve its performance too.

NEW WING DESIGN

McDonnell Douglas applied NASA studies into supercritical aerofoils to the design of the new and much longer wing, with a reduced sweep angle combining to give it a much higher aspect ratio. The NASA aerofoils provided increased lift with reduced drag. Interestingly these changes only caused the wing area to increase from 201.1ft^2 (18.68m^2) to 230 ft^2 (21.4m^2). The new wing design, the first carbon fibre technology wing fitted to a military aircraft was tested on two modified AV-8As, 158394 and 158395. These two aircraft were redesignated YAV-8Bs, the first flying on November 9, 1978, and the second on February 19, 1979. ➤

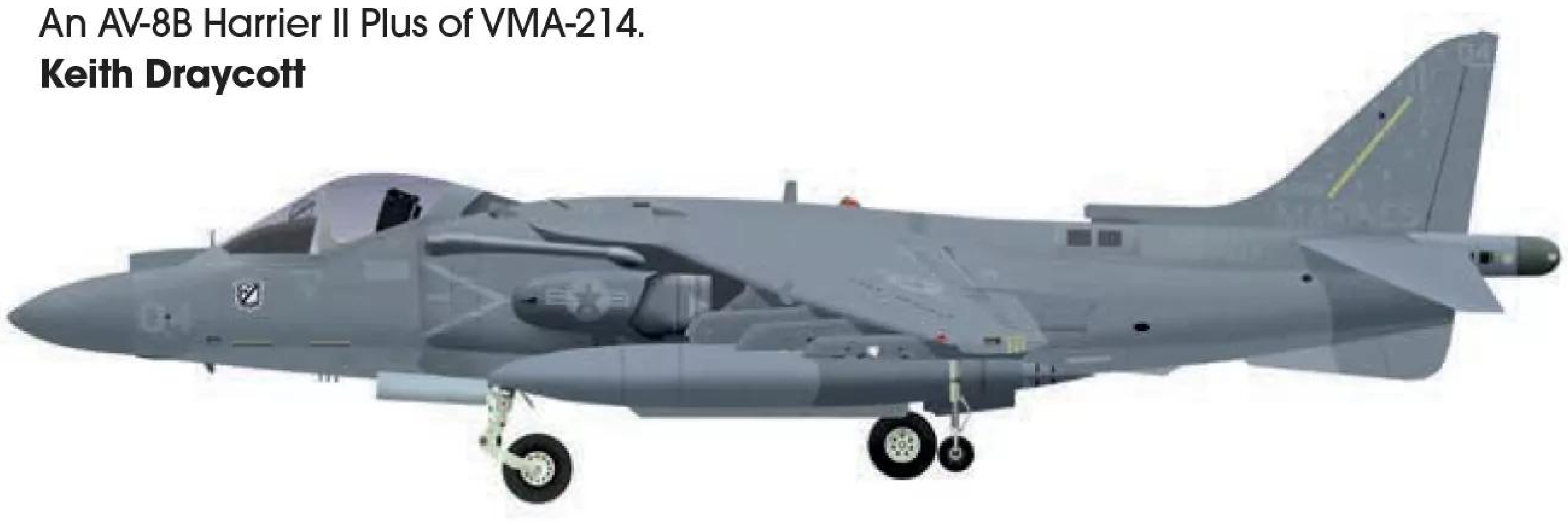
Two early USMC Harrier IIs, these AV-8Bs are the day attack version, as evinced by the lack of nose-mounted FLIRs. **Frank B. Mormillo**

The YAV-8Bs were fitted with improved engine intakes having two rows of blow-in doors, later amended to just one, and new flaps, called positive circulation flaps, that increased engine lift in the hover. The lift improvement devices from the AV-8C were fitted, as was a Pegasus 11 F402-RR-404 producing 21,750lb (9866 kg) of thrust equipped with a new gearbox and new 'zero-scarf' forward nozzles of greater effectiveness. These new nozzles and intakes alone provided an additional 800lb (363kg) of thrust. Trials with the two aircraft were very successful, even though 158395 crashed in November from an engine flameout. The only area needing modification was that the tests showed higher than expected drag, but the improvements in payload and range needed by the USMC were all there.

As result, four Full Scale Development (FSD) aircraft were ordered, the first flying on November 5, 1981, with a new forward fuselage and refined tailplane design. In total, 26% of the new aircraft's structure was made of modern composites which saved 480lb (217kg) over traditional construction. The AV-8B Harrier II had arrived.

While this was going on in the US, Hawker Siddeley, now part of British Aerospace, was working on its new wing with large Leading Edge Root Extensions (LERXs). In 1980, the McDonnell Douglas development was found to meet most of the RAF's needs for a future Harrier, so in August 1981 a Memorandum of Understanding (MoU) was signed between the two companies to jointly produce the new aircraft, with McDonnell Douglas taking 60% of the workshare on the airframe.

An AV-8B Harrier II Plus of VMA-214. **Keith Draycott**



On the engine production and development, Rolls-Royce took 75% of the workshare in a partnership with Pratt & Whitney. As a result of the agreement, the LERXs from the British wing concept were fitted to the AV-8B, increasing the total wing area to 243.4ft² (22.61m²) and reducing some of the drag problems encountered with the early trials. The only differences between the US and UK version of the Harrier II were that the UK's was fitted with different avionic systems, an additional missile pylon in front of each wing landing gear and strengthened leading edges of the wings to meet more stringent bird strike requirements.

The partnership meant that the programme would be cheaper for both Governments, an attractive proposition in lean times. The US ordered 12 AV-8Bs in 1979 to supplement the FSD aircraft in service trials, followed by additional orders for a further 325 aircraft. The UK were to order 60 of the first two versions of the Harrier II designated Harrier GR.5 and GR.5A in RAF service. The development paths required by the two services diverged at this point, so we will deal with the two streams separately, starting with the AV-8B.

The four FSD aircraft and first batch of 12 production AV-8Bs were all delivered by January 1985, with the first aircraft entering service with the USMC's training Squadron VMAT-203 at MCAS Cherry Point in January 1984. Aside from a wide range of guided and unguided bombs and rockets, the AV-8B Harrier II could carry the AIM-9 Sidewinder air-to-air missile, AGM-65 Maverick ground-attack missile, AGM-84 Harpoon anti-ship missile and the AGM-88 HARM anti-radiation missile. For

A pair of AV-8B Harrier II Plus aircraft of VMA-542 on the break. **François Prins**

ground strafing, the General Dynamics GAU-12 Equalizer 25mm five-barrelled Gatling cannon was mounted in the left under-fuselage pod with 300 rounds of ammunition, fed via a bridge between them, in the right pod. This was a much more powerful weapon than the earlier twin 30mm cannon, giving the aircraft a potent ground attack capability. Unguided bombs were delivered using the Hughes AN/ ASB-19 Angle Rate Bombing System (ARBS) mounted in the nose, a system initially developed for the USMC A-4 Skyhawks, but later fitted to the RAF's GR.7 as well as the early USMC AV-8Bs.

All of these initial batches of aircraft were day attack aircraft, a serious limitation that was addressed by the development, in 1985 of the Night Attack Harrier. McDonnell Douglas added Forward Looking Infra-Red (FLIR) equipment and a wide-angle Head Up Display (HUD) as well as made the cockpit compatible with the use of Night Vision Goggles (NVGs). Minor modifications to the placement of other equipment completed the modification programme, which was intended to be designated as the AV-8D, but was eventually termed the AV-8B (NA). A total of 72 new build aircraft were produced, after one trials aircraft, 162966, was converted from the 87th AV-8B built From the 15th aircraft on the production line, the AV-8B(NA)s were fitted with the last and most powerful version of the Pegasus, the 11-61 or F402-RR-408 of 23,800lb (10,795kg) thrust. The AV-8B (NA) entered service in 1989, with VMA-214 being the first to operate the type. By 1992, the Night Attack Harrier had completely replaced the day attack aircraft in service.

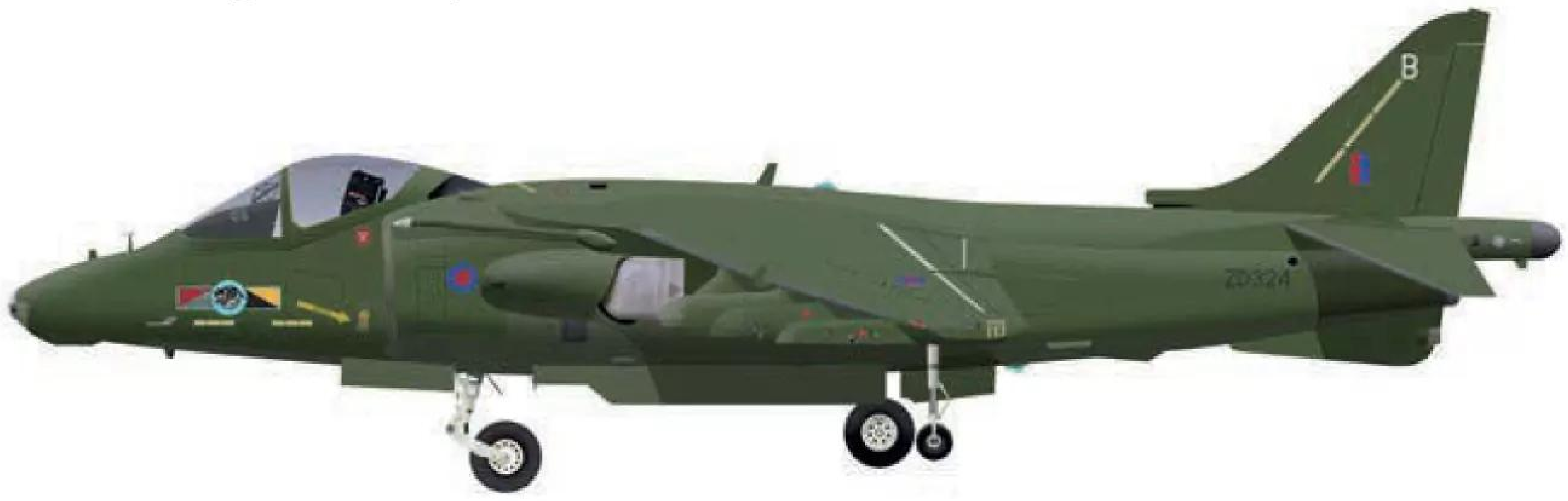
The next limitation to be addressed was to turn the AV-8B into a Beyond Visual Range fighter, similar in capability to the Sea Harrier FA.2. The AV-8B Harrier II Plus was the result of an MoU signed in June 1987 between BAE and McDonnell Douglas to develop a radar equipped version of the aircraft. In 1990, the MoU was expanded to include Italy and Spain who also expressed an interest in the aircraft.

The APG-65 pulse-doppler multi-mode radar was chosen for the simple reason that the USMC and Spanish Navy were operating the F/A-18, which also used the radar, and the commonality of equipment would reduce operating costs for both. The APG-65 required that an extended radome be fitted to the redesigned nose of the AV-8B, replacing the AN/ASB-19 ARBS. This advanced radar gave the AV-8B similar capabilities to the Sea Harrier, including the ability to carry the AIM-120 AMRAAM air-to-air missile with all the benefits that excellent system brings to any fighter.

Since the Harrier II Plus was based on the Night Attack Harrier, it had the Pegasus 11-61 and also retained all of the night capabilities of that aircraft. The first USMC unit to receive the aircraft was VMA-542 on July 8, 1993. Two more units, VMA-223 and VMA-231 also were equipped with the Harrier II Plus by 1994, and all three units were based at MCAS Cherry Point. The Harrier II Plus was also purchased by the Navies of Spain and Italy.

All three types of AV-8B saw operational service with the USMC, starting with the first Gulf War in 1991, continuing through Iraq and in support of ground forces in Afghanistan. Lastly, with the acquisition of McDonnell Douglas by Boeing in 1998, ➤

A Harrier GR.5 of 233 OCU comes into land in a forest clearing. The additional weapons pylon fitted to RAF Harrier IIs is visible over the undercarriage outriggers. **BAE SYSTEMS**



A Harrier GR.5 of 233 OCU based at RAF Wittering. **Keith Draycott**

Showing the huge disparity in size, two Harrier GR.5s of 20 Squadron in formation with a Harrier GR.3 and T.4 of 233 OCU. **BAE SYSTEMS**

An AV-8B(NA) of VMA-214. **Frank B. Mormillo**

Four AV-8B Harrier II Plus radar equipped strike fighters of VMA-311 at San Diego for the 100th Anniversary of Naval Aviation, 2010. **Frank B. Mormillo**

A pair of Harrier GR.7s, one armed with AGM-65 Maverick missiles, in formation with an RAF VC-10 tanker. **BAE SYSTEMS**

and the amalgamation of British Aerospace into BAE Systems, the Harrier became known as the BAE/Boeing Harrier.

The RAF development of the Harrier II began with the Harrier GR.5, of which 41 were built, the first making its maiden flight on April 30, 1985, before entering service with 233 Operational Conversion Unit (OCU) at RAF Wittering in July 1987. The GR.5 differed from the AV-8B day attack configuration in several respects. Twin 25mm Aden cannon were mounted in separate under-fuselage pods, there was an additional weapons pylon under the outrigger wheels and additional leading-edge protection against bird strikes was fitted.

The GR.5 used the AV-8B's ARES mounted in the nose but changed other avionics. A Ferranti movingmap display, different radio and IFF systems and a different countermeasures suite were among these changes. The odd looking 'chin' bulge on the underside of the nose was to be fitted with a Miniature Infrared Linescan (MIRLS) to enable all-weather reconnaissance in addition to the FLIR, but this device was never fitted. The aircraft was powered by the Pegasus 11-21 Mk 106 of 21,750lb (9866 kg) thrust. After the 41 GR.5s had come off the production line at Kingston, an additional 19 new aircraft were built to the GR.5A standard and three were converted from GR.5s. None of these modified aircraft ever entered service, instead each was converted to the next RAF version, the GR.7.

As a side note to main development story, the politically motivated choice of the 25mm Aden cannon as a replacement for the older 30mm Aden on the Harrier GR.3s was an unmitigated disaster. Despite repeated trials, new contractors and endless modifications, the gun never worked satisfactorily, if at all. The pods remained fitted to the Harriers, as they performed an important aerodynamic function in the hover, but rarely, if ever, were there guns in them. In 1999, the entire farce was cancelled by the MoD, who stated, "The Harrier GR.7 had no operational role that required the use of automatic weapons". Operation Palliser over Sierra Leone in 2000 proved the opposite, as the Harriers had no weapon with which to engage the rebels. Lastly, and perhaps most damning, a Parachute Regiment major in Afghanistan, described the Harrier's gun-less air support as "utterly, utterly useless". Again, politics had served to hamstring this remarkable aircraft, a factor which was to be its final undoing in UK service.

ENTER THE GR.7

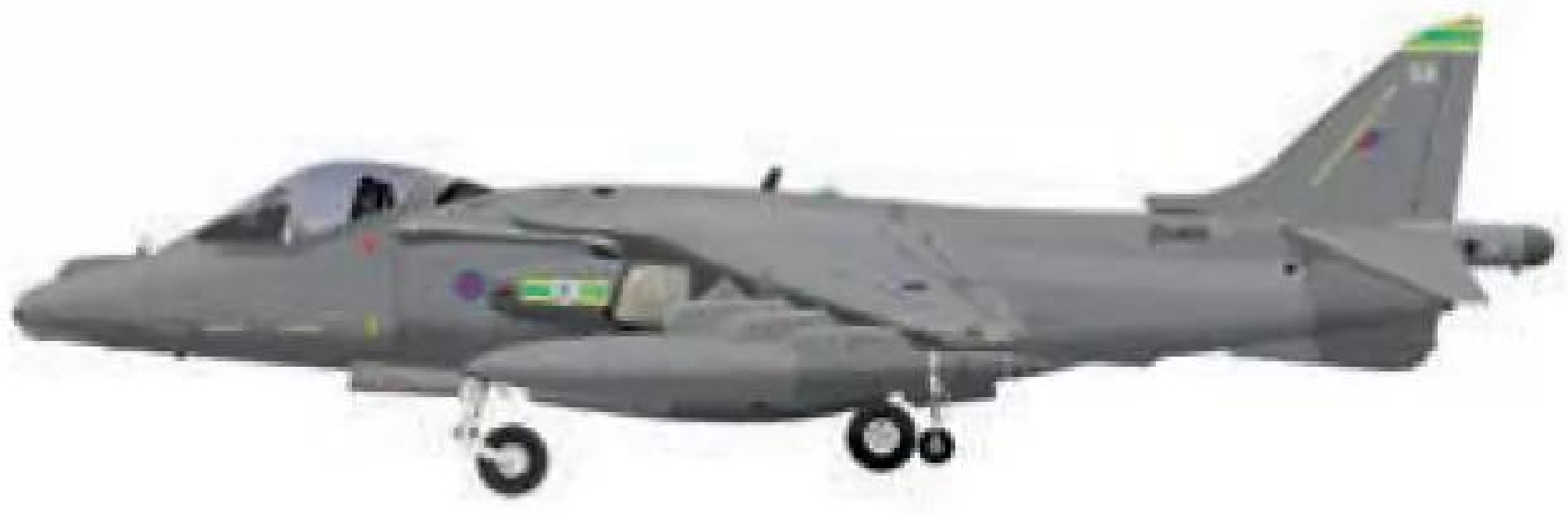
The Harrier GR.7 was roughly equivalent to the Night Attack Harrier II, but with a number of changes to the avionics suite. A GECMarconi 1010 FLIR was fitted in a small fairing above the nose and a Smiths Industries wide-angle HUD and GEC-Marconi colour map display were fitted in the NVG-compatible cockpit The GR.7 flew for the first time on November 20, 1989, with 34 new build aircraft being produced and 53 GR.5 and 5As were converted to the new standard. During production, the 70% LERX was changed for the 100% version, which was then retrofitted across the fleet. The NVG's posed an interesting safety problem when it came to the use of the ejection seat. If they were still on the pilot's helmet, their weight could have cause injury or even death in the high forces of ejection. To remedy this, the Martin-Baker 12 Type 2 seat was fitted with a connection to a compressed air source which would blow the goggles off before the seat fired. Ingenious!

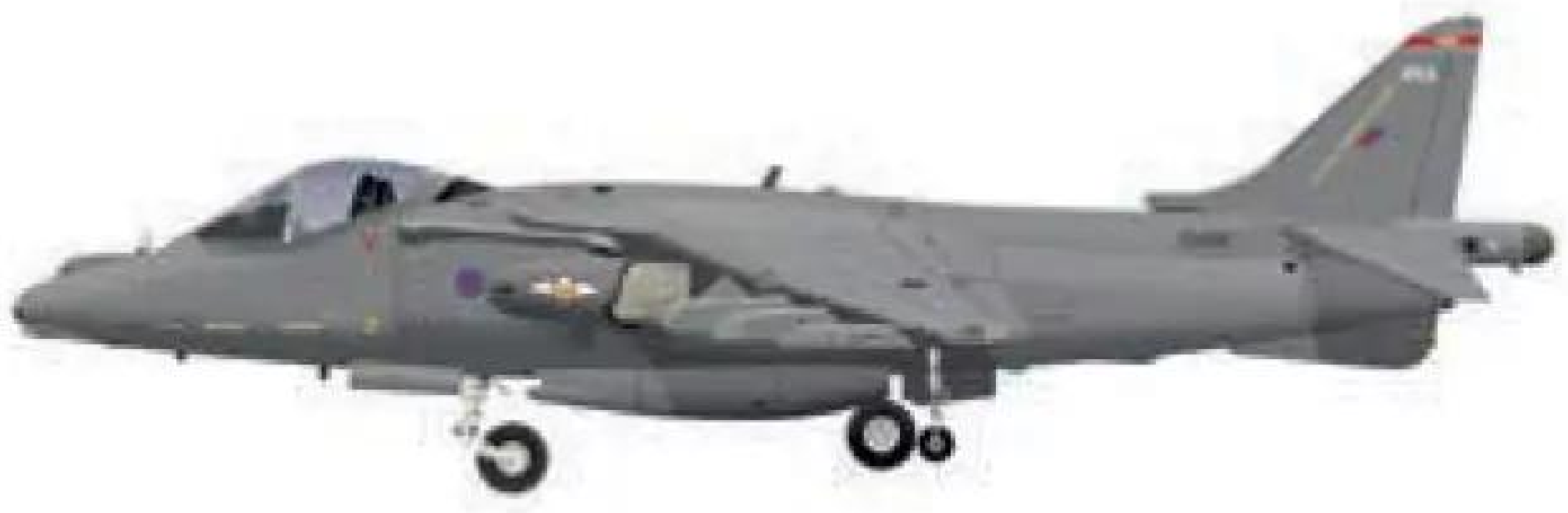
A Harrier GR.7 in the early green camouflage scheme. carrying four rocket pods. **BAE SYSTEMS**

The GR.7 entered service on September 12, 1990, when 4 Squadron converted directly onto the type from the GR.3. In 1992, the GR.7 units participated in Operation Warden over northern Iraq. Flying from bases in Turkey, the sorties were aimed at preventing further attacks on the Kurdish people. This deployment was followed by the first of several deployments over the Balkans, taking part in Operation Deny Flight and Operation Deliberate Force in 1995, continuing into Operation Allied Force in 1999. The outcome of these operational deployments for the Harrier was an increase in capability as the aircraft was modified in the light of lessons learned from combat missions. The GR.7 could now carry the Vinten reconnaissance pod and Thermal Imaging Airborne Laser Designator (TIALD) pod. Lastly, the AGM-65G2 Maverick was cleared for use by the GR.7 after the need for a stand-off attack weapon became clear over Kosovo.

After a number of successful deployments aboard, Royal Navy carriers

A Harrier GR.7 at an airshow, showing some of its arsenal to the public. **Joe Walsh**


A Harrier GR.7 of 3 Squadron. **Keith Draycott**


A Harrier GR.7A of 1 Squadron. **Keith Draycott**

The first Harrier GR.9 on an early test flight. **BAE SYSTEMS**

A Harrier GR.7 taxies in at night, canopy open showing the NVG compatible lighting in the cockpit. **BAE SYSTEMS**

starting in 1997, 2000 saw the formation of Joint Force Harrier (JFH) which brought RAF and Royal Navy Harrier Squadrons into a common command structure as part of Britain's Joint Rapid Deployment Force. In 2003, the GR.7s were again at war, this time over Iraq as part of Operation Telic, which again is dealt with separately. From 2004 Harriers of the JFH were deployed to Afghanistan to support the troops on the ground, fighting a resurgent Taliban and other militant forces as part of Operation Herrick. They were withdrawn from this operation in 2010, being replaced by Tornado GR.4s.

While all these deployments were going on, the next development in the RAF Harrier story came about, driven by a number of hard lessons learned. Operations over Iraq and onboard ship had highlighted the need for more power, so the Pegasus 11-61 Mk 107 of 23,800lb (10,795kg) thrust was ordered in 1999 and fitted to 20 existing GR.7s to between 2002 and 2004 create the GR.7A. This upgrade was meant as an interim solution while the last of the RAF Harrier variants, the GR.9 was developed. The GR.9 upgrade was applied via the £500m Joint Update and Maintenance Programme (JUMP), which upgraded the Harrier fleet during normal maintenance periods in a series of incremental stages. Beginning in mid-2006, these updates included software upgrades to the communications, ground proximity warning and navigation systems and integration of the AGM-65 Maverick air-to-ground missile.

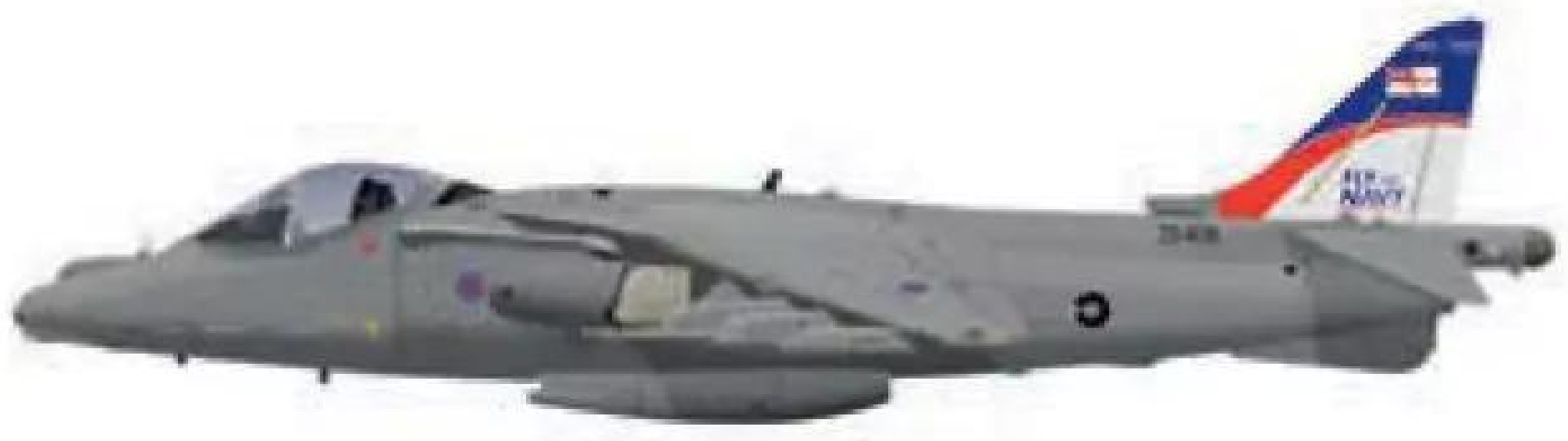
The RAF's Rangeless Airborne Instrumentation Debriefing System (RAIDS), Raytheon's Successor Identification Friend or Foe (SIFF) system, the ability to carry the new Paveway IV guided bomb and the Digital Joint Reconnaissance Pod (DJRP) were all part of the process to keep the Harrier at the cutting edge of technology until the F-35 lightning II was ready to enter service as the Harrier's replacement. The first GR.9 was accepted into service in September 2006. Eventually, 10 GR.9s were upgraded from GR.7s and 30 GR.9As were created by upgrading GR.7As. The first operational deployment of the Harrier GR.9 was in January 2007 in Afghanistan as part of the NATO International Security Assistance Force (ISAF).

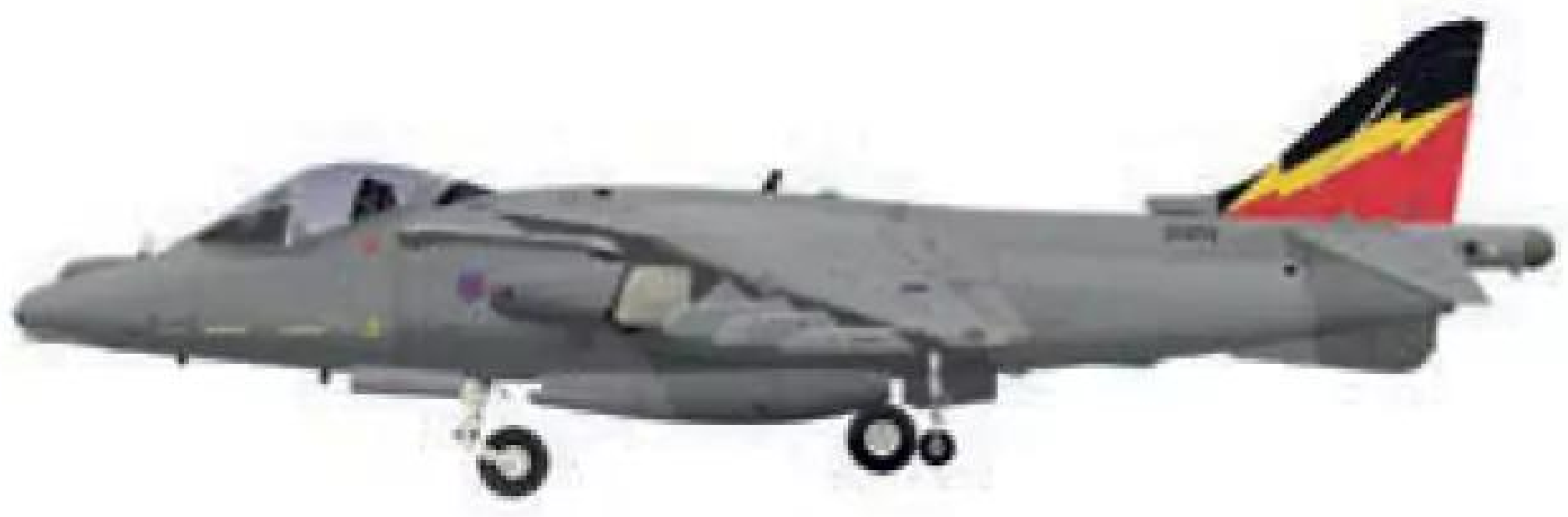
While all this was going on, an Urgent Operational Requirement (UOR) was issued in late 2006 for a new pod, resulting in the first AN/AAQ-33 sniper Advanced Targeting Pod being test-flown on a Harrier GR.9 on December 1, 2006. A contract was given to Lockheed Martin to deliver the pod on 26 February 2007, and deliveries were completed by June 2007.

Sniper was far more accurate than the earlier TIALD pod and was needed over Afghanistan to identify targets. In 2007, an £84m contract was awarded to BAE Systems to fit the Tactical Information Exchange Capability (TIEC) system to the aircraft. The first TIEC test flight was successfully made by a GR.9 on June 29, 2010, from Warton, during which the system communicated successfully with an AWACS and a ground unit. In April 2009, BAE Systems was awarded a new £574 million Harrier maintenance contract to support the aircraft until 2018. The last Harrier GR.7 was retired on March 30, 2010, leaving only the GR.9 and 9A in service.

Everything was set for the pattern of Afghan deployments and planned maintenance to continue when, on October 19, 2010, as part of the UK government's Strategic Defence and Security Review, it was announced that the Harrier was to be retired by April 2011, for reasons of cost and 'limited capabilities', a euphemism for its politically inspired lack of a gun. In fact, the last flights were made in December 2010, and the fleet retired to storage with almost undignified haste. ■

Words: Tim Callaway


A Harrier GR.9 of the Naval Strike Wing in an anniversary scheme to commemorate the 100th year of Royal Naval Aviation. **Keith Draycott**


A Harrier GR.9 of 4 Squadron, wearing the Squadrons flash on its fin. **Keith Draycott**

The F-35B STOVL version – the Harrier replacement, now in service with the RAF and Royal Navy. **Lockheed Martin**

Battle Diary 2

78 days on continuous operations – RAF Harrier GR.7s in Operation Allied Force, 1999

A day-by-day account of the sorties flown by Harriers on Operation Allied Force.

Operation Allied Force was NATO's air campaign aimed at ending the offensive by Yugoslav Army and Serbian interior ministry police units in Kosovo. This was the second time NATO air power had been used to intervene in the area, having undertaken a similar task during 1995 in Bosnia and Herzegovina. The air campaign led to the withdrawal of Yugoslav forces from Kosovo, establishment of the United Nations Interim Administration Mission in Kosovo (UNMIK), and finally brought to an end to the Yugoslav Wars of the 1990s. This diary details only the involvement of the RAF's Harrier squadrons in the campaign, which lasted from March 24 to June 10, 1999. It is intended to show the fast pace of operations, the difficulties encountered by the crews in theatre, the long hours worked by the ground crews and the exceptional availability rate of this incredibly reliable aircraft. The personnel were drawn from all four RAF Harrier squadrons during the long campaign.

DAY 1 – MARCH 25, 1999

Six RAF Harrier GR.7 fighter-bombers took part in the first night of NATO attacks against Serbian military positions after a last-ditch diplomatic effort failed on Tuesday (March 23) following the Serbian refusal to sign a peace deal brokered in Paris earlier this month. Just over an hour after the first attacks by cruise missiles at 6pm British time, the Harriers were tasked to attack an ammunition storage facility used by the Ministry of Interior Police during its repression of the Kosovar Albanians. Four aircraft were armed with Paveway II laserguided bombs with the others acting as escorts. These aircraft formed part of the third wave of attacks against the facility, and because of explosions, fire and smoke caused by the earlier strikes, the Harriers had difficulty in seeing and maintaining a lock on its targets. Paveways released by the lead aircraft lost lock after release and fell short of the target on open ground. As a consequence, the remaining Harriers aborted the attack and returned to base in Italy without releasing the weapons.

Harrier chic! A GR.7 pilot after a successful sortie at Gioia del Colle. **Jack Pritchard**

DAY 2 – MARCH 26, 1999

RAF Harriers were at the forefront of NATO attacks on the second day of Allied Force. Once again six aircraft were involved, and the target was an ammunition store within Serb barracks at Leskovic. The targeted barracks was home to an anti-aircraft unit and an infantry unit. Weapons and equipment stored included anti-aircraft guns and ammunition, man-portable surface-to-air missiles as well as mobile radar installations and self-propelled guns. Of the three targets attacked, the Harriers successfully destroyed two, while a technical problem with one aircraft in the third pair after lock resulted in the run being abandoned without the release of weapons. All six aircraft returned safely to base at Gioia del Colle, Italy.

DAY 3 – MARCH 27, 1999

Once again, RAF Harriers were at the front of NATO attacks against Serbian targets. Eight Harriers were launched, but poor weather obscured the target area and the aircraft abandoned the mission without releasing weapons. Other NATO aircraft in the same waves were also called back prematurely. All NATO aircraft once again returned without any losses. Elsewhere in the region, two Yugoslav MiG-29s were shot down over Bosnia-Herzegovena further illustrating the superiority NATO has over the Serbian forces.

DAY 4 – MARCH 28, 1999

The RAF has despatched an additional four Harriers from No. 1 Squadron, RAF Wittering, to Gioia del Colle as well as another Tristar tanker from No. 216 Squadron, RAF Brize Norton, to Ancona as an additional air-to-air refuelling asset for all NATO forces involved in Allied Force missions.

DAY 5– MARCH 29, 1999

The previous night four Harriers attacked an ammunition storage site near Pristina used by the Serbian Interior Ministry Police. All the aircraft self-designated and six Paveway Us were released against three large buildings in the complex; five successfully guided to the intended point of impact, while the sixth failed to guide and fell on open ground near the target area. The fourth aircraft involved in the mission was illuminated by a Serb anti-aircraft system and jettisoned its bombs. Confirmation was also given that the four extra Harriers for Allied Force had arrived in theatre bringing the total to 12.

DAY 6 – MARCH 30, 1999

Last night's intended Harrier strikes once again fell victim to bad weather over the target area of Pristina Pol, although targets were hit by NATO cruise missiles.

DAY 7 – MARCH 31, 1999

RAF Harriers undertook the first daylight sorties against targets in and around Kosovo. As in recent days, the weather once again defeated the crews of many NATO aircraft over target areas and were forced to return to bases without releasing bombs.

Close up of the RBL755 cluster bombs and Sidewinder missile on the wing of a Harrier GR.7. **Jack Pritchard**

A Harrier GR.7 taxies out in miserable weather at Gioia del Colle. Weather was to play a very restricting role in the air campaign. **Jack Pritchard**

A Harrier GR.7 taxying out at Gioia del Colle with two 1000lb bombs. **Jack Pritchard**

DAY 8 – APRIL 1, 1999

Once again bad weather in the region prevented RAF Harriers and other NATO aircraft from carrying out planned attacks.

DAY 9 – APRIL 2, 1999

RAF Harriers were once again unable to participate in Operation Allied Force due to bad weather – the fourth consecutive day this has happened.

DAY 10 – APRIL 3, 1999

NATO's planned attacks were once again severely curtailed by the weather.

DAY 11 – APRIL 4, 1999

The weather was not the reason for cancellation of the day's planned attacks by the Harriers from Gioia del Colle; a technical problem with a support aircraft involved in the mission meant that the Harriers, as well as other NATO aircraft, had to postpone strikes.

DAY 12 – APRIL 5, 1999

RAF Harriers were part of a package operating over Western Kosovo attempting to locate Serb targets in the area. None were engaged.

DAY 13 – APRIL 6, 1999

Two daylight 'seek-and-destroy' sorties were flown by Harriers over Southern Kosovo. As on the previous day, no targets were engaged, a sign that the Serbs were hiding heavy weapons in an attempt to escape detection, rather than using them against the ethnic Albanians.

DAY 14 – APRIL 7, 1999

During the day, 10 Harriers were involved in attacks against Serbian forces in Kosovo. Four separate target sets were attacked, including tanks and a convoy of 15-20 vehicles. The Harriers dropped cluster munitions, which are highly effective against these kinds of targets, and initial indications show that these were very successful attacks.

DAY 15 – APRIL 8, 1999

Ten Harriers were again airborne over Kosovo during the day on 'seek-and-destroy' missions in conjunction with aircraft from other NATO countries. Operating in pairs, only one pair was tasked with an attack, and after identifying the target (a military vehicle compound), successfully carried out a strike using RBL755 cluster munitions.

DAY 16 – APRIL 9, 1999

Harrier missions over Kosovo during daylight hours continued the previous day, and two sets of targets were attacked by four aircraft. The first was a military vehicle compound in southern Kosovo, and the second was against military vehicles parked on a road in western Kosovo. Both strikes were made using cluster munitions, and early reports suggest that they were successful.

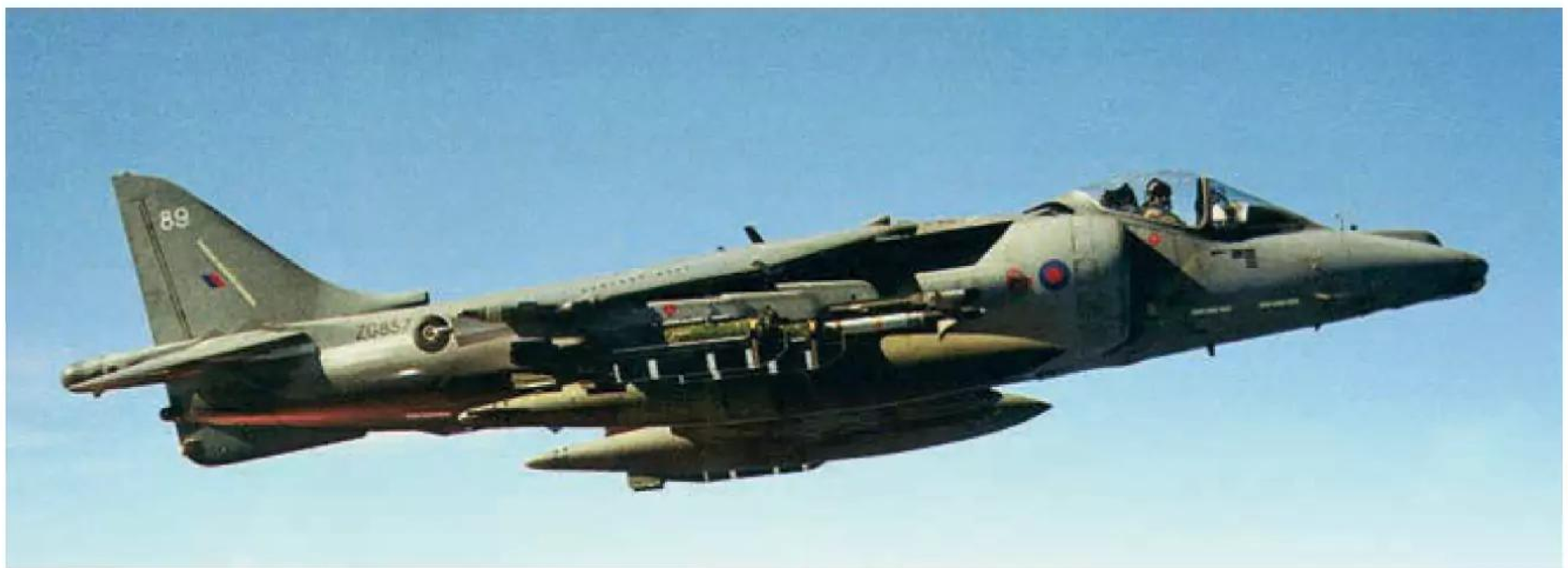
DAY 17 – APRIL 10, 1999

After the recent good weather in the Balkans, the number of missions flown by NATO aircraft the day before was severely curtailed due to unfavourable conditions in the target area.

DAY 18 – APRIL 11, 1999

Good weather allowed Harrier GR.7s from Gioia del Colle to take part in both day and night attacks in Kosovo. The daylight mission saw six aircraft involved in operations against a military storage area and military relay station in Kosovo. The Harriers involved in the night attacks were less successful. A late change of target allocation forced the aircraft to abort the mission because the risk of collateral damage could not be assessed. Once again, no aircraft were lost and all returned safely to base.

The Harriers were parked in open ended shelters for loading. Here an aircraft is armed with a single RBL755 and a Paveway II laser guided bomb. **Jack Pritchard**



A Harrier GR.7 joins up alongside a tanker on the way in to a sortie. The bomb tally under the cockpit denotes one Paveway mission, three RBL755 missions and five 1000lb bomb missions. **Jack Pritchard**

DAY 19 – APRIL 12, 1999

A total of 16 Harrier missions were flown over Kosovo. The day attacks concentrated on Serbian army and special police forces in Kosovo. Initial indications show that targets hit included a soft skin vehicle and surface-to-air missile battery. Partial cloud cover forced one formation to abandon its attack on a convoy when it could not be positively identified as military vehicles or refugees. The attacks during the night were against a petrol storage facility in Kosovo. All of the aircraft involved in the missions returned home safely. Targets engaged by RAF aircraft were attacked for the first time through cloud using 1000lb (454kg) 'dumb' bombs.

DAY 20 – APRIL 13, 1999

NATO flew its highest number of missions yesterday in a maximum effort against Serbian Forces. During the day, 10 Harriers attacked mobile Serbian military targets in Kosovo, dropping 20 1000lb (454kg) bombs in the process.

DAY 21 – APRIL 14, 1999

Partial cloud cover in the Balkans reduced the air activity, but 10 Harriers did manage to complete missions during the day. The Harriers were tasked with a series of attacks on military targets in Kosovo and three sites were targeted; four aircraft released weapons on a fuel dump near Pristina and the remainder engaged a military relay station and radar site. The weapons used in the attacks were RBL755 cluster bombs – a radar-guided version of the standard BL755 munition – and standard 1000lb bombs.

DAY 22 – APRIL 15, 1999

The RAF's contribution to yesterday's actions included 12 Harrier missions against an ammunition dump in Kosovo as it was unable to identify suitable mobile or tactical Serbian Army and Special Police targets. Reports indicate that these attacks, using 1000lb bombs, were successful.

The shelters were not always effective at keeping the worst of the weather off the aircraft. **Jack Pritchard**

DAY 23 – APRIL 16, 1999

RAF Harrier GR.7s flew its highest number of missions in a single day the day prior -18. These concentrated on three key areas; command and control facilities in Pristina, artillery and anti-aircraft sites. Once again, all aircraft returned home safely.

DAY 24 – APRIL 17, 1999

RAF Harriers were tasked with 22 missions yesterday, however only two pairs of aircraft flew due to deteriorating weather conditions. The first pair were unable to locate a target of opportunity and so were allocated an alternative target. This target was believed to a Pristina Army Corps Tactical Headquarters used to command and direct Serbian Special Forces in Kosovo and maintain communications with Belgrade. In the end, both pairs of aircraft attacked the target using RBL755 cluster munitions. The Harriers were carrying four of these weapons, each capable of deploying 147 separate bomblets.

DAY 25 – APRIL 18, 1999

RAF Harriers successfully attacked Serbian Army and Special Police Forces in Kosovo with RBL755 cluster bombs. Early indications are that an armoured personnel carrier and military soft-skinned vehicles were hit.

DAY 26 – APRIL 19, 1999

The weather over the Balkans was particularly poor the previous day and this severely curtailed RAF participation in NATO missions. Several Harriers did manage to get airborne, but were unsuccessful in locating enemy targets and returned to base. Two of the aircraft were forced to divert to the civilian airport at Bari because of high crosswinds at Gioia del Colle.

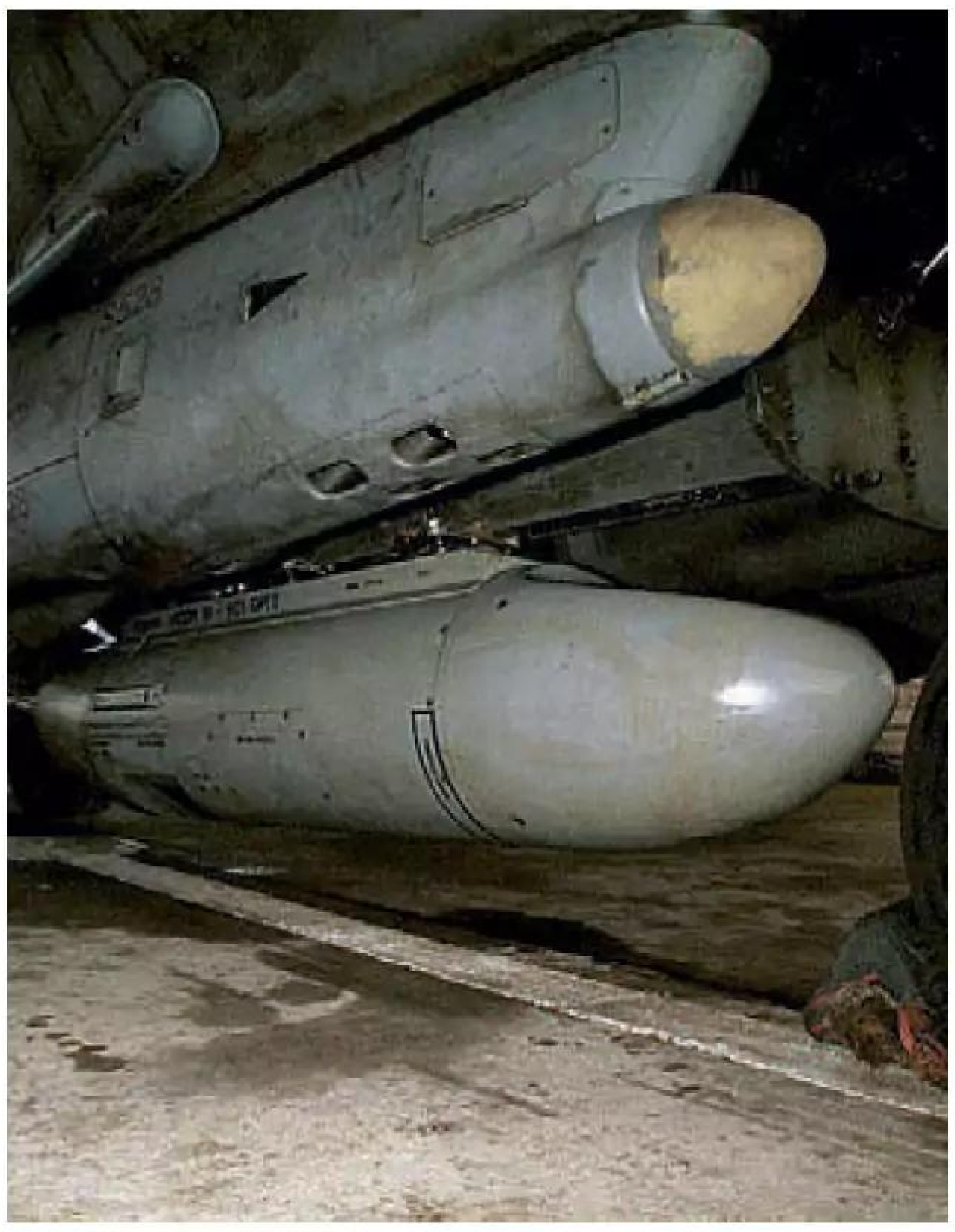
DAY 27 – APRIL 20, 1999

Despite some poor weather over Kosovo again the day before, Harriers flew a total of 20 sorties. Four aircraft attacked a unit

Taxying out on another RBL755 mission. **Jack Pritchard**

The ground crews worked in terrible conditions, their job made more hazardous by wet and slippery aircraft. **Jack Pritchard**

Ground crew diligence is one of the factors in the remarkable reliability rate of the Harrier in service. **Jack Pritchard**



The Harriers also flew reconnaissance missions with the Vicon camera pod, here mounted on the centreline fuselage pylon. **Jack Pritchard**

of the Serbian Army near Urosevac airfield, a further four attacked a mobile command post and the petrol, oil and lubricants (POL) facility at Pristina. The final group of Harriers were involved in CAS missions against ground targets, but none were allocated to them and all returned to Gioia del Colle without releasing any weapons.

DAY 28 – APRIL 21, 1999

Four RAF Harrier GR.7s attacked a Serbian Army Command Post in Kosovo through cloud with 1000lb bombs. The weather, however, prevented other Harrier GR.7s from finding and attacking Serbian Army and Special Police targets in Kosovo. Royal Navy Sea Harrier FA.2s, operating from HMS *Invincible*, provided Combat Air Patrols in support of NATO forces.

DAY 29 – APRIL 22, 1999

Unfortunately, extensive low cloud and rain prevented the Harriers from attacking targets. Sea Harriers flew Combat Air Patrol from HMS *Invincible*, thereby allowing other dual role NATO aircraft to take part in air operations over Kosovo and Serbia.

DAY 30 – APRIL 23, 1999

Harriers attacked a military command post with cluster bombs, and Sea Harriers from HMS *Invincible* flew combat air patrols. However, the inclement weather forced several RAF Harrier's to return from missions with weapons, having been unable to attack targets with the precision-guided munitions onboard.

DAY 31 – APRIL 24, 1999

The bad weather prevented RAF Harrier GR.7s from attacking its particular targets. RN Harrier FA.2 aircraft, operating from HMS *Invincible*, carried out air defence combat patrols as part of NATO's continuing determination to maintain air superiority throughout the operational area.

DAY 32 – APRIL 25, 1999

The previous day was the busiest day, so far, for the RAF Harrier GR.7s. Twenty sorties were flown, attacking a variety of targets in Kosovo with a combination of RBL755 Cluster bombs and Laser Guided Weapons. A road bridge, an Army Command Post, military installations on an airfield and a dug-in artillery position were attacked.

DAY 33 – APRIL 26, 1999

NATO operations were again affected by the weather.

DAY 34 – APRIL 27, 1999

NATO operations concentrated on targeting assembly areas, Serb Army and Special Police Infrastructure and key petrol, oil and lubricants facilities. NATO also attacked facilities at Podgorica airfield in Montenegro, a radio relay site and a munitions storage area. A television transmitter on top of the Socialist party HQ building in Belgrade was also attacked.

DAY 35 – APRIL 28, 1999

Fifteen Harrier sorties were flown and RBL755 cluster bombs were dropped through cloud in an attack on the Besinje ammunition storage area.

DAY 36 – APRIL 29, 1999

The RAF Harrier GR.7s flew 11 missions, dropping both Laser Guided Bombs, Paveway II, and Cluster Bombs, RBL755.

DAY 37 – APRIL 30, 1999

RAF Harrier GR.7s flew 10 sorties and dropped a number of RBL755 cluster bombs on a military vehicle compound and a barracks near the border. Another four Harrier GR.7s will deploy to Gioia Del Colle bringing the total to 16.

DAY 39 – MAY 2, 1999

12 RAF Harrier GR.7 sorties were flown in the last 24 hours: targets included the Djakovica army barracks and a rail bridge in Serbia.

➤

Four 1000lb bombs waiting to be loaded on to a Harrier GR.7. **Jack Pritchard**

It could also be incredibly hot at Gioia del Colle, which had its own hazards. **Jack Pritchard**

DAY 40 – MAY 3, 1999

RAF Harrier GR.7s were heavily involved in the attacks against the Serbian military and special police force targets in Kosovo, engaging armour revetments using RBL755 cluster bombs. The Harriers also successfully attacked a petrol station that was being used to shelter and refuel Serbian military vehicles.

DAY 41 – MAY 4, 1999

The RAF Harrier GR.7s flew 17 missions against Serbian military and special police forces in Kosovo, dropping mainly RBL755 cluster bombs as well as some 1000lb bombs. The targets were armoured vehicles, deployed troops and military vehicles.

DAY 42 – MAY 5, 1999

RAF Harrier GR.7s flew eight missions in the close air support role against targets in Kosovo, and 32 RBL755 cluster bombs were dropped on artillery and armoured vehicles.

DAY 43 – MAY 6, 1999

Although the RAF Harriers GR.7s flew several successful operational missions, some particular targets were not suitable for attack in the weather conditions which were encountered in the target area, and consequently the Harriers did not release any weapons.

The low visibility formation lights glow green as Harrier GR.7s move out for a night sortie. **Jack Pritchard**

DAY 44 – MAY 7, 1999

The RAF Harrier GR.7s were not involved in any attacks conducted today. The additional four Harrier GR.7 aircraft have now arrived at Gioia Del Colle, making a total of 16 GR.7s now based in Southern Italy.

DAY 45 – MAY 8, 1999

Seven Harrier GR.7s flew sorties, attacking Sjenica airfield with 1000lb bombs dropped through cloud. Other Harriers flew but did not release weapons because of the unsuitable weather.

DAY 46 – MAY 9, 1999

The RAF Harriers GR.7s flew 16 sorties against Serbian Army and Special Police tactical targets in Kosovo. Armoured vehicles, deployed artillery and a troop staging area were attacked with RBL755 cluster bombs and 1000lb bombs.

DAY 47 – MAY 10, 1999

Six RAF Harriers participated in today's missions, attacking a petroleum store in Pristina with 2 Paveway II LGBs and four 1,000lb bombs. A secondary target was also hit using four 1000lb bombs, three of which impacted successfully while the fourth exploded in the air possibly due to a munitions failure.

DAY 48 – MAY 11, 1999

Over 20 attack missions were flown by RAF Harriers and Tornados; the Harriers struck a radio relay site and Serbian mortar and artillery positions.

DAY 49 – MAY 12, 1999

There were 20 attacks by Harriers against a variety of targets including an ordnance repair depot, a communications site, fielded Serbian forces and petroleum storage sites.

As one aircraft departs on a mission, another is readied in the non-stop bombing campaign. **Jack Pritchard**

A Harrier GR.7 using the short take off technique as it is heavily loaded with 1000lb bombs. **Jack Pritchard**

DAY 50 – MAY 13, 1999

RAF Harriers flew 20 sorties and dropped over 40 weapons of various types against fielded forces and a motorway bridge.

DAY 51 – MAY 14, 1999

Sixteen Harrier sorties were flown from Gioia del Colle. Seven aircraft were able to successfully identify and attack targets; Pristina airfield, a road bridge and deployed troops and vehicles were hit.

DAY 52 – MAY 15, 1999

Twenty-two RAF attack missions were flown – 16 by Harriers and six by Tornado GR.1s. Targets included an army barracks and two bridges as well as attacks on Serbian forces in Kosovo, a staging area, military vehicles and prepared ground positions.

DAY 53 – MAY 16, 1999

18 Harrier sorties were flown. The Harrier targets included a road bridge in Kosmaka and fielded forces, including armoured vehicles, in Kosovo.

DAY 54 – MAY 17, 1999

Harrier GR.7s flew eight sorties, but only one aircraft was able to release its weapons, striking artillery with four RBL755 cluster munitions, due to the poor weather.

DAY 55 – MAY 18, 1999

Sixteen Harrier missions were launched from Gioia del Colle, but only one aircraft was able to release its weapons against a road bridge, again, due to the poor weather.

DAY 56 – MAY 19, 1999

The weather deteriorated still further. Only six RAF Harrier sorties were flown but were unable to attack any targets.

DAY 57 – MAY 20, 1999

This day was a planned rest day for the RN's Sea Harrier FA.2s and the RAF's Harrier GR.7s.

DAY 58 – MAY 21, 1999

Persistent poor weather with extensive low cloud caused the cancellation of the majority of the day's attack missions.

DAY 59 – MAY 22, 1999

The RAF contribution to today's attacks totalled 19 Harrier and six Tornado GR.1 sorties. Targets which were successfully hit included military concentrations throughout Kosovo and an engineering depot in Serbia.

DAY 60 – MAY 23, 1999

A total of 18 Harrier GR.7 sorties were flown but, because the targets were obscured by partial cloud cover, only some of the aircraft released weapons. However, a radio relay station was successfully struck by two aircraft.

DAY 61 – MAY 24, 1999

Harrier operations suffered at the hands of the weather with none of the aircraft involved able to release weapons.

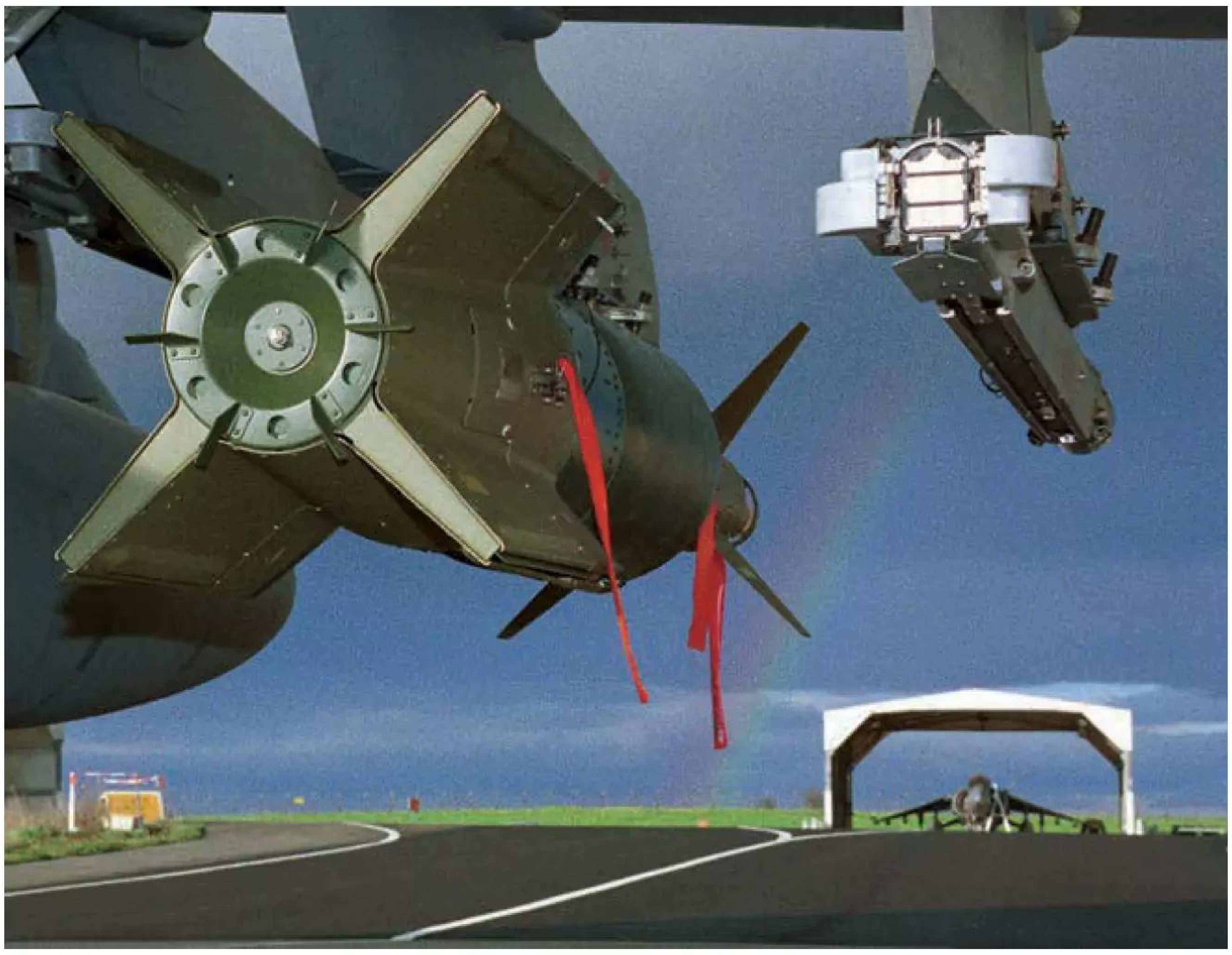
DAY 62 – MAY 25, 1999

Only eight Harrier missions were flown because of the weather, and none of the aircraft were able to drop any weapons.

DAY 63 – MAY 26, 1999

A further 20 Harrier missions were flown today. The Harriers successfully attacked a Serbian Army mortar position and a military supply depot.

➤



A rainbow forms over a Paveway II as the weather breaks at Gioia del Colle. **Jack Pritchard**

DAY 64 – MAY 27, 1999

Harriers flew a further 20 sorties the previous day. Some allocated targets were not hit because of cloud partially obscuring the objective, but a successful attack was made against mortar revetments.

DAYS 65-68 – MAY 28-31, 1999

On Friday, Tornado GR.1s attacked a highway tunnel and an explosive factory. On Saturday, Harrier GR.7s attacked revetted military vehicles, mortar and artillery positions and armour, releasing a total of 20 x RBL755 cluster bombs. On Sunday, Harrier GR.7s attacked a range of well established, well dug in Serb Army positions in Kosovo, releasing 8 x RBL755 cluster bombs and 8 x 1000lb bombs.

DAY 69 – JUNE 1, 1999

The RAF contributed a further 20 Harrier missions the previous day and these were concentrated on a Serbian Army storage depot.

DAY 70 – JUNE 2, 1999

RAF attacks were carried out by Harriers, and were against two artillery positions and a mortar position.

DAY 71 – JUNE 3, 1999

RAF Harriers flew 18 missions and were involved in attacks on artillery and dug in forces in Kosovo using RBL-755 and 1000lb bombs.

DAY 72 – JUNE 4, 1999

Twenty RAF Harrier sorties were flown the previous day, and attacked Serbian artillery pieces, mortar positions and armoured vehicles using 1000lb bombs and RBL755s. Details of the transfer of additional RAF elements to the region to support the movement of ground troops into Kosovo once the details of the peace agreement have been signed was also given today. Eight Chinook and four Puma support helicopters will start deploying from bases at Odiham and Benson on June 5 to Macedonia.

Pilot pre-flight checks of the aircraft and munitions are a vital part of flight safety. **Jack Pritchard**

DAY 72 – JUNE 4, 1999

Twenty RAF Harrier sorties were flown the day before, and attacked Serbian artillery pieces, mortar positions and armoured vehicles using 1000lb bombs and RBL755s.

DAYS 73-75 – JUNE 5-7, 1999

NATO air strikes against Yugoslav targets were scaled down over the weekend in the hope that a peace agreement was about to be signed. RAF involvement was reduced with eight Harrier reconnaissance flights being flown on June 5.

DAY 76 – JUNE 8, 1999

With the stepping up of the air campaign after the failure of the peace talks over Kosovo, RAF aircraft once again made a significant contribution to the allied effort. Harriers from Gioia del Colle flew 20 sorties against a mix of artillery and mortar positions with good results.

DAY 77 – JUNE 9, 1999

RAF Harriers flew 14 sorties in both ground-attack and reconnaissance roles with Vicon camera pods.

DAY 78 – JUNE 10, 1999

There were no combat sorties by RAF Harriers.

OPERATION JOINT GUARDIAN JUNE 11-14, 1999

NATO attack sorties were suspended following the signing of the Military Technical Agreement, but RAF Chinook and Puma support helicopters continue to provide air mobilisation for personnel and equipment within Kosovo. RAF attack aircraft remain at a high-level of readiness to resume operations, if required.

JUNE 22, 1999

RAF Harriers returned to home base at Wittering after the NATO air campaign had officially been terminated some days earlier. Ten Harriers returned home, leaving six still in theatre at Gioia del Colle to support NATO ground forces if required. ■

Words: Tim Callaway

The bond between air and ground crew is never more poignant that at the moment of departure. **Jack Pritchard**

Battle Diary 3

RAF Harrier GR.7 in Operation Telic – the second Gulf War

The refusal of Saddam Hussein's Iraqi regime to comply with UN Security Council Resolution 1441 to allow weapons inspectors free access to the country sparked the second war in the region in only 12 years. Unlike the first Gulf War of 1991, RAF Harriers played their part.

The military campaign to end the rule of the Hussein regime in Iraq began in the early hours of March 20, 2003, when US strike aircraft and cruise missiles struck military targets in and around the capital Baghdad.

The land offensive began later on the same day, after nightfall, with the Royal Marine units leading coalition forces to secure the port of Umm Qasr, the Al Faw peninsula and the strategically important Rumalayah oilfields.

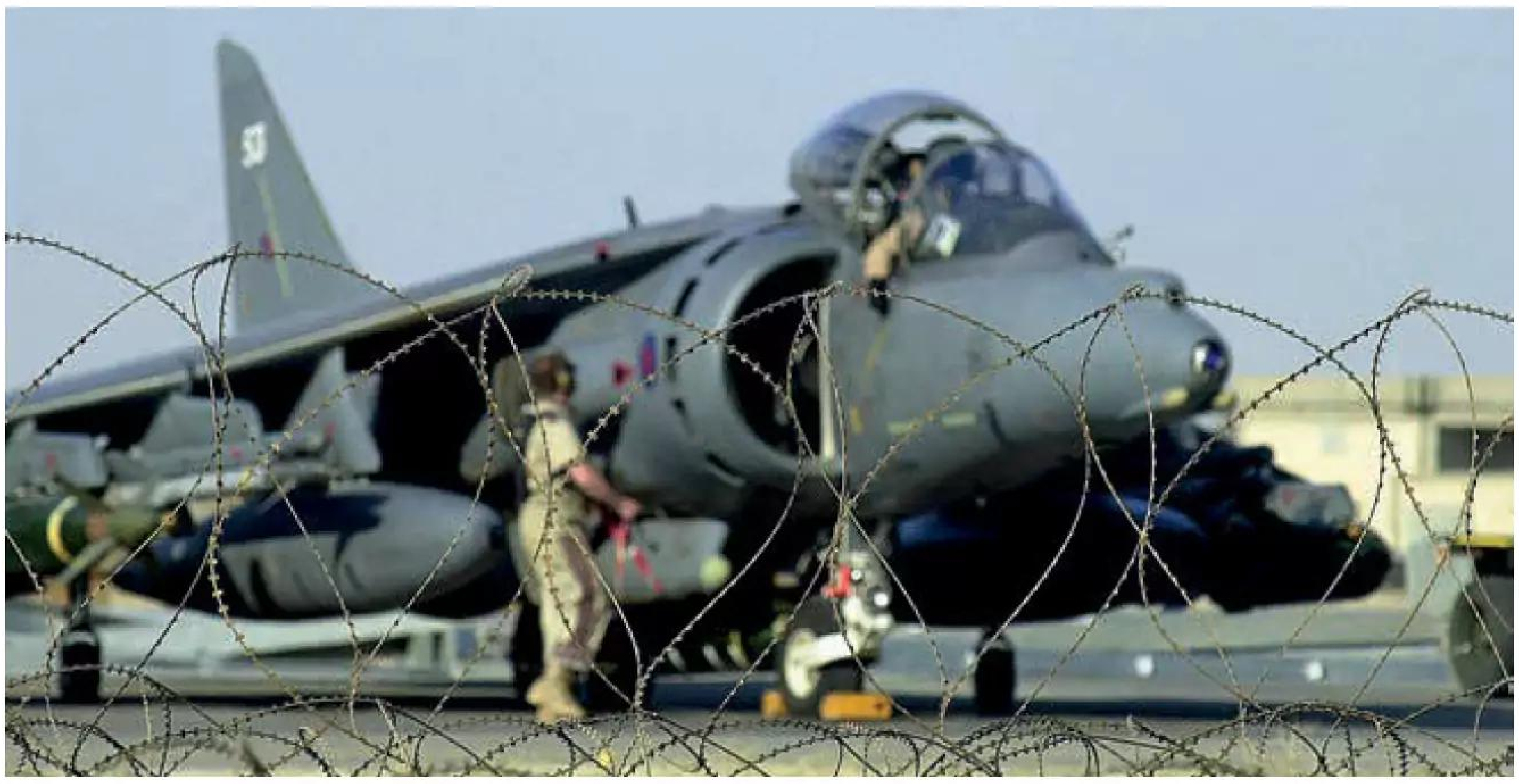
The British deployment to support the coalition forces, known as Operation Telic, was of similar size to that of the 1991 Gulf War Operation Granby. From January 7, the first of a total of 46,000 British servicemen and women began to deploy to Kuwait, Saudi Arabia, and other countries in the region. The last to deploy was the air element of the forces, which began moving into theatre on February 6.

Once the build-up was complete, an ultimatum issued to the Hussein regime ran out on March 20, and the first air attacks began followed by a land invasion of southern Iraq. Less than a month later, on April 14, the US announced that the main fighting was over, with only pockets of resistance remaining in the far north of the country.

This article details the involvement of the RAF Harrier GR.7 units committed to the coalition air forces during the conflict. The Harrier Wing was spilt into two elements, the first consisted of ten Harrier GR.7s from 1 and 3 Squadrons, emulating the Harrier GR.3 force that had operated 21 years earlier in the Falklands War. The second element was made up of eight Harrier GR.7s of 4 Squadron who were based at Al Jaber in Kuwait.

The Harriers of the Royal Air Force were in action from opening hours of Operation Telic. On March 21, Harrier GR.7s provided close air support to British and American land forces involved in operations over a wide area of southern Iraq. Tornado GR.4s attacked defending artillery positions with Enhanced Paveway II GPS-guided bombs and were involved in operations to the north at Al Kut.

The following day saw two new weapons added to the RAF's arsenal. The Storm Shadow stand-off missile for the Tornado GR.4 was used for the first time and a Harrier GR.7 fired a Maverick air-to-ground missile for the first time, both on March 22.

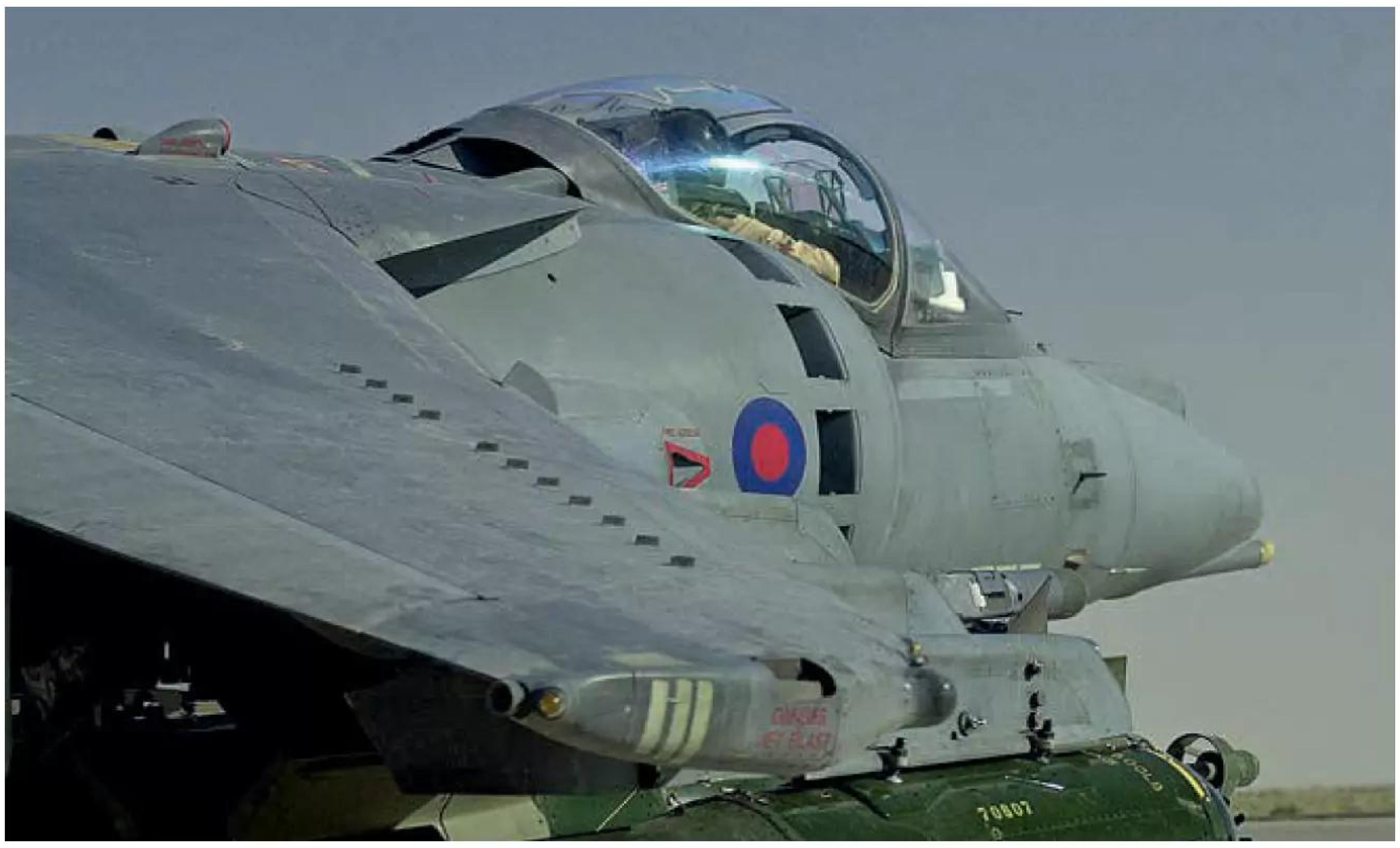

A Harrier GR.7 is readied for a sortie, armed with a RBL755 CBU, a Paveway III LGB, a pair of Sidewinder missiles and two 30mm cannon. **Jack Pritchard**

The Harriers launched two of the missiles against a mobile SCUD launch site some 200 miles into Iraq. It successfully engaged and destroyed the target. These were announced at a press conference in Qatar on March 23, where Major General Peter Wall, Chief of Staff of the United Kingdom's national contingent, said: "The RAF has been involved in operations around the clock since the campaign began, flying over 100 sorties a day." This pace was to continue for the whole of the campaign.

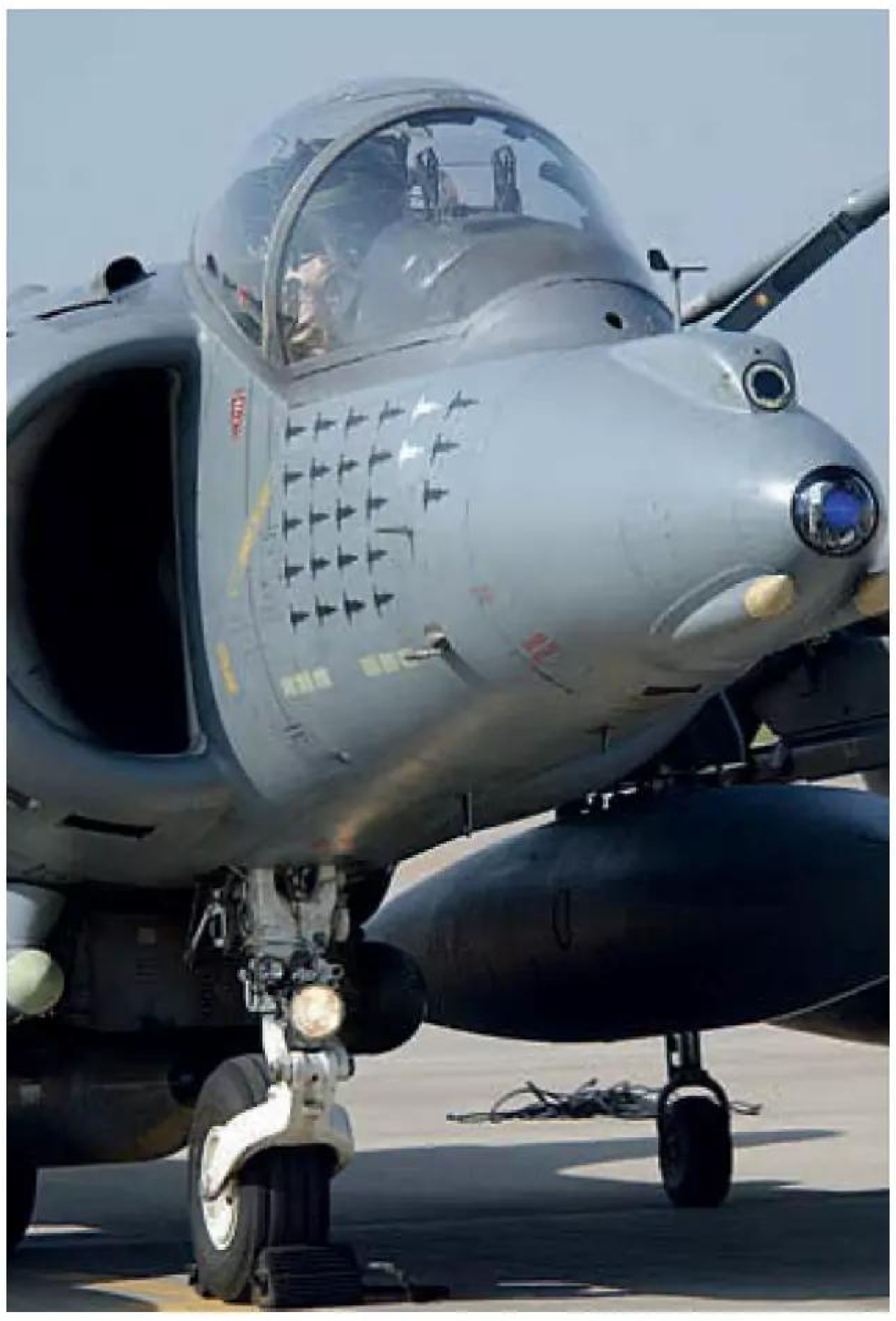
Most of the sorties carried out by RAF Harriers were close air support missions to coalition forces on the ground. This was typified on March 27 when a number of Iraqi tanks attempted to break out from Basra towards the captured Al Faw peninsula. These were attacked by RAF Harrier GR.7s in partnership with other coalition aircraft, successfully halting an attempt to retake the port of Umm Qasr.

The Harriers were also tasked with disrupting the supply lines to Iraqi forces.

The operations over Iraq occurred night and day, taking advantage of the Harrier's night vision capabilities. **Jack Pritchard**



An RBL755 CBU, Paveway and Sidewinder hang from the wing of this Harrier GR.7. CAS missions were mostly flown with a mixed load of ordnance, to deal with any target that might come up from the FAC. **Jack Pritchard**



The scoreboard on the nose of this Harrier GR.7 records 25 LGB missions flown. **Joe Walsh**

On March 30, Harrier GR.7s struck at the main fuel dump at Karbala, destroying it and leaving military vehicles and aircraft in the region critically short of fuel.

There were two major influences on the equipment carried by the Harriers during Operation Telic. The first was the weather; the shamal winds of the region have the ability to create sandstorms that can last for several days, reducing visibility and damaging equipment. On a number of occasions these sandstorms completely grounded all of the coalition air forces.

The second factor was that the majority of sorties were conducted at medium level, above 8000 feet, not at low level where the Harrier had been designed to operate. The reason for this was the perceived nature of the threat from Iraqi air defences, lessons learned from the first Gulf War. Medium level operations gave pilots more time to identify, counter and then nullify any AAA threat from the ground, and kept them out of range of small calibre ground fire.

As a result of these changes, the Harriers carried a number of different systems and weapons for this campaign to any that had gone before. During their operations in Operation Deliberate Force over the Balkans in 1995, the Harriers had suffered from a lack of an autonomous laser designation system for their precision guided munitions.

Jaguar aircraft, equipped with the Thermal Imaging Airborne Laser Designation (TIALD), had marked targets for the Harriers in that campaign. During Operation Allied Force, this need had been addressed when Jaguar TIALD pods had been modified to be carried by Harriers, giving them a greater reconnaissance capability and allowing them to designate their own targets. These pods were carried again in Operation Telic, but to mark targets for a new generation of Laser Guided bombs, the Enhanced Paveway or EPW.

The large AGM-65G2 Maverick missile was added to the Harrier's arsenal during Operation Telic. **Keith Draycott**

Lessons from Kosovo had changed the design of the bombs as well, giving them greater accuracy under a variety of poor weather conditions and greater range after release, both ideal modifications for the conditions of Operation Telic.

Guidance could come from laser designation as with the earlier versions of the weapon, but in bad weather the weapon could be guided by its own autonomous Global Positioning System Aided Inertial Navigation System (GAINS). The bombs were produced in two versions. EPWII was based on a general purpose 1000lb (453kg) bomb for use against relatively soft targets. To destroy armour or hardened buildings, the EPWIII was developed based around a 2000lb (905kg) penetrator warhead, essentially a steel armoured bomb. These two weapons were used with great effect by the Harrier on a wide variety of targets.

The other new weapon has already been mentioned, the AGM-65G2 Maverick air-to-surface guided missile. The Maverick was added to the RAF's arsenal again because of the lessons of Kosovo. During this campaign it became obvious that the Harrier lacked a precision guided stand-off weapon with which to attack heavily defended targets or targets requiring the element of surprise. These large missiles, like the EPWs, had autonomous guidance once the target was locked, making them a fire-and-forget weapon capable of being launched at long or short ranges, ideal for the situation in Iraq. In all, 30 Mavericks were fired by Harrier GR.7s in the conflict.

The Harriers flew continually throughout the campaign, occasionally against preplanned targets on specific tasking, but mostly on a flying alert basis to provide CAS. A Forward Air Controller would have aircraft come up on his position and enter a local holding pattern. Once a threat or target was detected, the aircraft could be called down from the hold to provide near instantaneous close air support. This was often needed because of the speed of advance of the ground forces, and coincidentally was material in preventing blue-on-blue friendly fire incidents. Because of this technique, to many observers on the ground, it seemed the Harrier was permanently hovering over the battlefield, a reassuring presence.

In all 1736 RAF offensive sorties were flown, nearly 10% of the coalition total, by an RAF contingent that made up only 6% of the coalition air forces. Of these missions, Harrier GR.7s flew 23% of them, second only to 31% for the numerically superior Tornado GR.4 deployment.

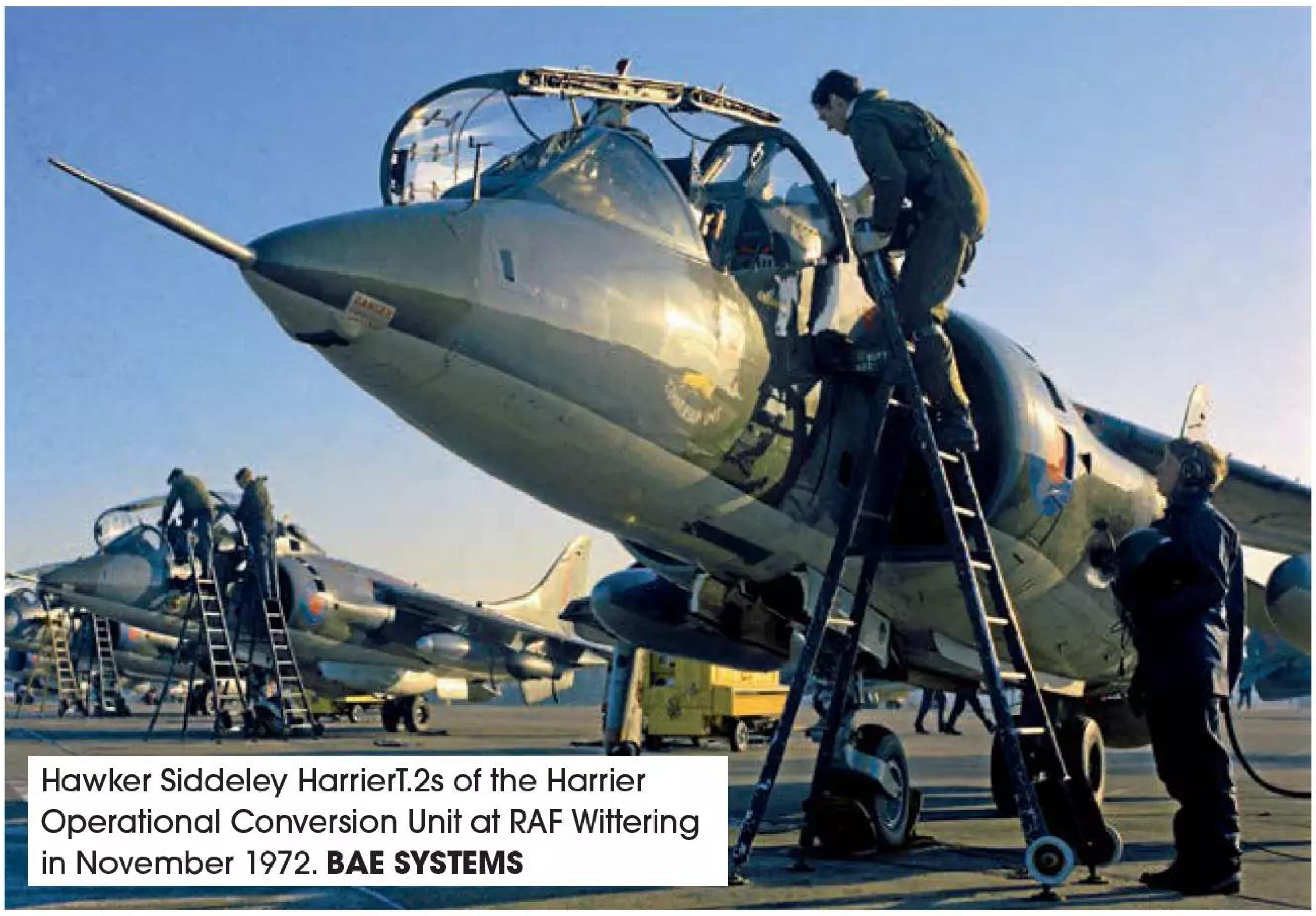
As the fighting died out in the middle of April, the level of air power in the region was reduced and the Harrier units returned to the UK at the end of April and the beginning of May. It had been a short and intense war and one of the most controversial of all time.

Whether or not you believe that it was a justifiable conflict or a shameful act of aggression based on trumped up evidence, the fact remains that once the British forces were committed, they played their part brilliantly. Casualties on both sides were minimised by the careful use of modern firepower and the task was completed quickly and professionally. The Harrier had proved itself yet again, but it had two more wars to fight. One it would win, the other, the political battle, it would lose. ■

Words: Tim Callaway

The Trainers

The Harrier T.2 to T.12 and the TAV-8A and B

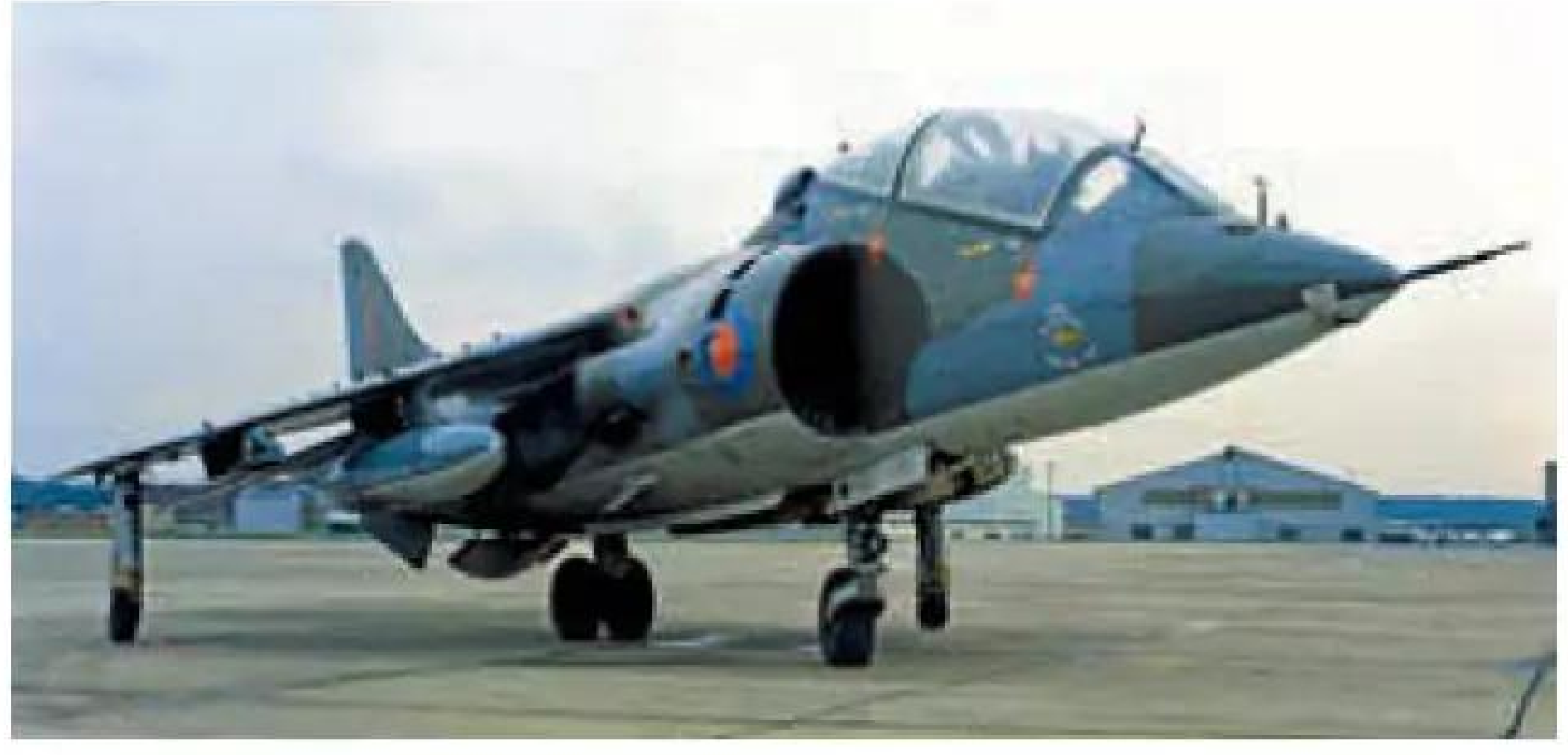


Hawker Siddeley HarrierT.2s of the Harrier Operational Conversion Unit at RAF Wittering in November 1972. **BAE SYSTEMS**

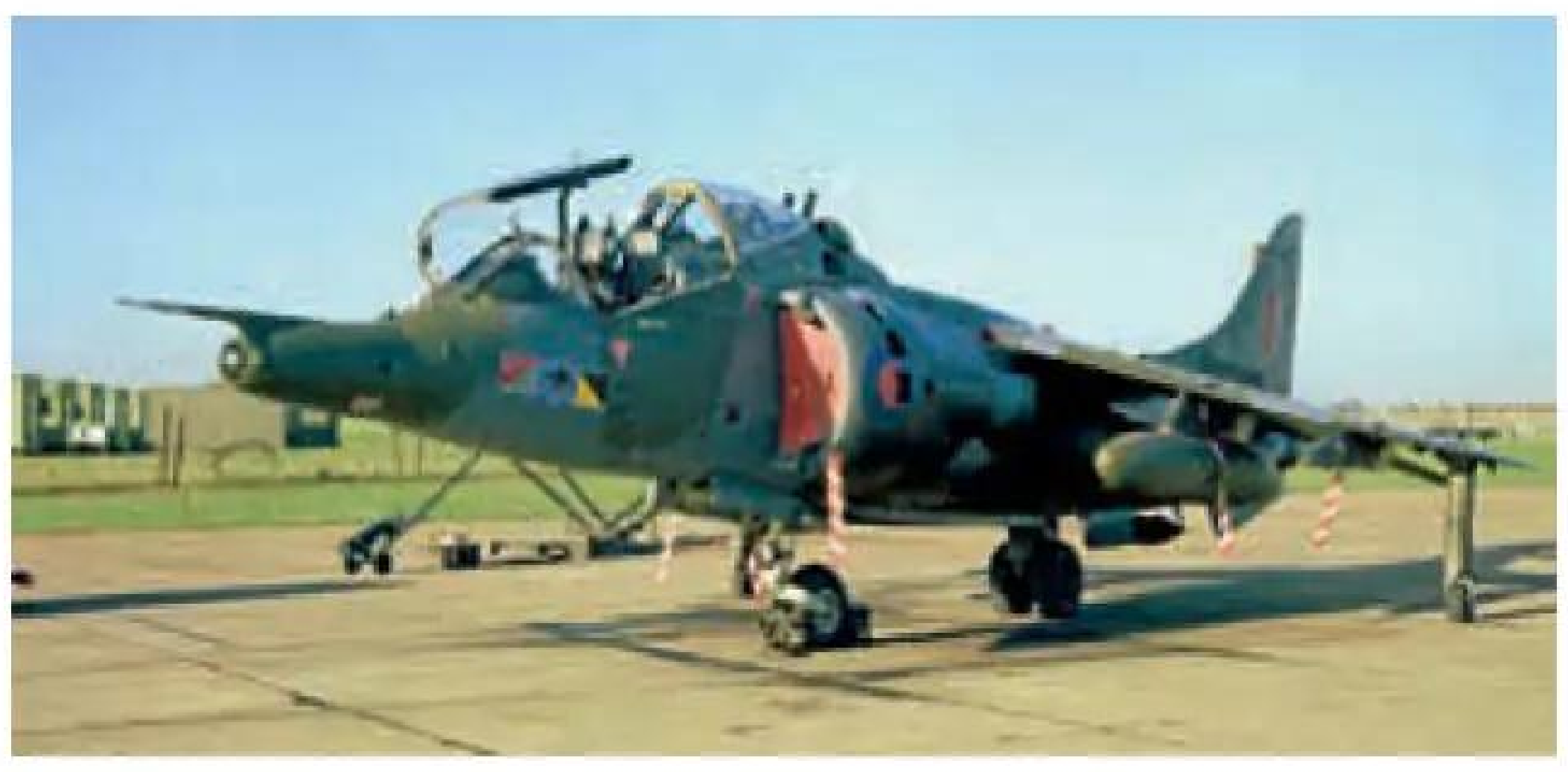
EJECTION SEAT
HARRIER OPERATIONAL CONVERSION UNIT

A close-up of the 'cricket' badge on the nose of a Hawker Siddeley Harrier OCU T.2. **BAE SYSTEMS**

A line-up of Hawker Siddeley Harrier OCU aircraft reveals that you need an enormous ladder to get into the back seat of a T.2. **BAE SYSTEMS**



Hawker Siddeley Harrier T.2 XV270 photographed at RAF Wittering in 1973. **BAE SYSTEMS**



A Hawker Siddeley Harrier T.4 of 233 OCU at RAF Wittering in November 1981. Note the LRMTS nose on his version of the trainer. **BAE SYSTEMS**

The unusual handling of the new VTOL aircraft and the unique skills required of its pilots led to the development of a range of two-seat trainer variants to assist in converting pilots to the Harrier. Prior to its introduction, a new pilot's first solo flight was also his first flight!

Ralph Hooper of Hawker Aircraft was a very busy man in 1966. Aside from overseeing the final design modifications to the six pre-production P.1127 (RAF) aircraft, he was suddenly presented with a new development project which was to cause its own problems with regard to modifying the new airframe.

In June, 1966, the British Government had authorised a one-year study programme to examine the feasibility, and likely costs, of developing a two-seat trainer version of the Harrier as it was now officially named. The RAF was already making plans to develop a structured training course for the aircraft, which included a short helicopter course to introduce trainees to the reality of vertical flight. Even with this vertical training element, it was decided that the Harrier was so unusual that a two-seat trainer would be likely to reduce the training accident rate, not to mention be able to be pressed into service to supplement the combat fleet in the event of war.

To this end, Ralph Hooper turned his attention to the very difficult task of fitting a complete second cockpit, with all the attendant equipment, into a small airframe already completely full and close to its weight limits. To solve the weight problem, Hooper contacted Bristol Siddeley, which was already looking at increased thrust versions of the Pegasus which would satisfy the trainer's needs. This settled, he began detail design work in order to accommodate the second cockpit.

Firstly, the nose was lengthened by 47 inches (1.2m) simply by moving the existing cockpit forward. In the space created, the second cockpit was added, but raised 18 inches (0.45m) for a number of reasons. Firstly, the instructor in the back would be able to see over the pupil's head. That might sound elementary, but a number of jet training aircraft, such as the Folland Gnat and T-33, were in service where the instructor could see forward only by leaning to one side and looking down the spaces on either side of the pupil's head and seat. Not a good way to fly, let alone teach someone else to fly!

Because the new cockpit was going to cause both a weight and an aerodynamic balance problem, the space under it was used to house equipment that had been in the extreme nose of the single seater, like the F.95 camera and some of the avionics. Moving these items aft lessened the balance problem but did not solve it. To offset the increased nose weight, a new tailcone, 33 inches (0.84m) longer than the original, was added which contained around 180lb (81.6kg) of ballast. The entire fin was moved aft by 33.3 inches (0.85m) and the fin fillet was modified to take account of this. The fin also now sat on top of an 11-inch (0.28m) tall extension.

All these modifications solved the question of weight balance, but only partly addressed the aerodynamic balance problem. Under the fuselage a new and larger ventral fin was added on the centreline, immediately below the modified fin, to balance the increased side area of the new nose. In tests, even this was found to be insufficient to maintain directional stability, particularly at high angles of attack, so a further 18-inch (0.45m) extension was added to the top of the fin.

➤

The new design was given the company designation of HS.1184, and the study revealed that the cost of a two-seater would be £1.15 million, as opposed to £0.85 million for the single-seater. This was deemed acceptable by the Treasury, which after approving an order for two pre-production development aircraft as part of the study, ordered 14 production examples of the trainer, designated Harrier T.2 and powered by the Pegasus 6 MklOl engine producing 19,000lb (8618kg) of thrust. The last four aircraft of this first batch of trainers, XW926 and 7 and XW933 and 4, were modified to take the Pegasus 10 Mk102 with 20,500lb (9299kg) of thrust, and these were designated as Harrier T.2As. The first 10 T.2s were later upgraded to T.2A standard with the addition of this engine.

In 1969, the first pre-production prototype, XW174, made its first flight in the hands of test pilot Duncan Simpson on April 22, followed by the second aircraft on July 14.

These trainers had the full avionics, navigation and attack systems of the single-seaters, the only exception being there was no moving map display in the rear cockpit, making them fully combat capable aircraft.

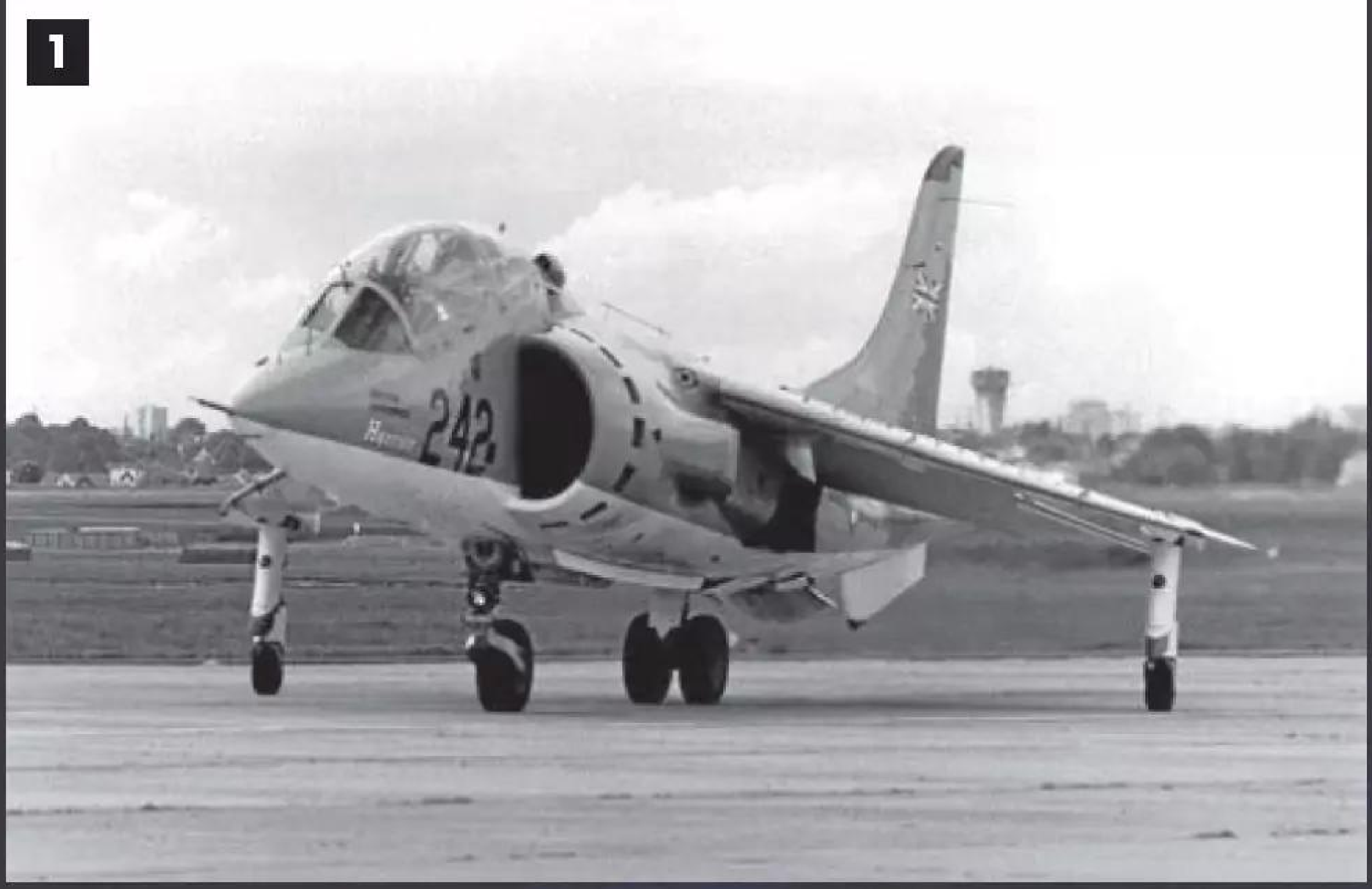
With the advent of the Harrier GR.3 with its nose-mounted Laser Ranger and Marked Target Seeker (LRMTS), the T.2As were further modified with the addition of the same system in the nose and the greater power of the Pegasus 11 Mk103 with 21,500lb (9752kg) thrust. They also carried the Radar Warning Receiver (RWR) equipment of the GR.3, mounted in the fin and rear fuselage. The new trainer was known as the T.4, with 13 T.2As being modified to this standard, alongside 12 new aircraft being built in small batches between 1976 and 1987.

The Royal Navy took an interest in the trainer for the Sea Harrier fleet, ordering a single example of a T.4, XW268, before the development of the navalised T.4N. Three T.4Ns were built and had avionics more suitable for training Sea Harrier pilots, with the exception of the Blue Fox radar, which was not fitted. All four naval trainers were also not fitted with the RAF's extended LRMTS nose, but in all other respects were fully combat capable as attack aircraft.

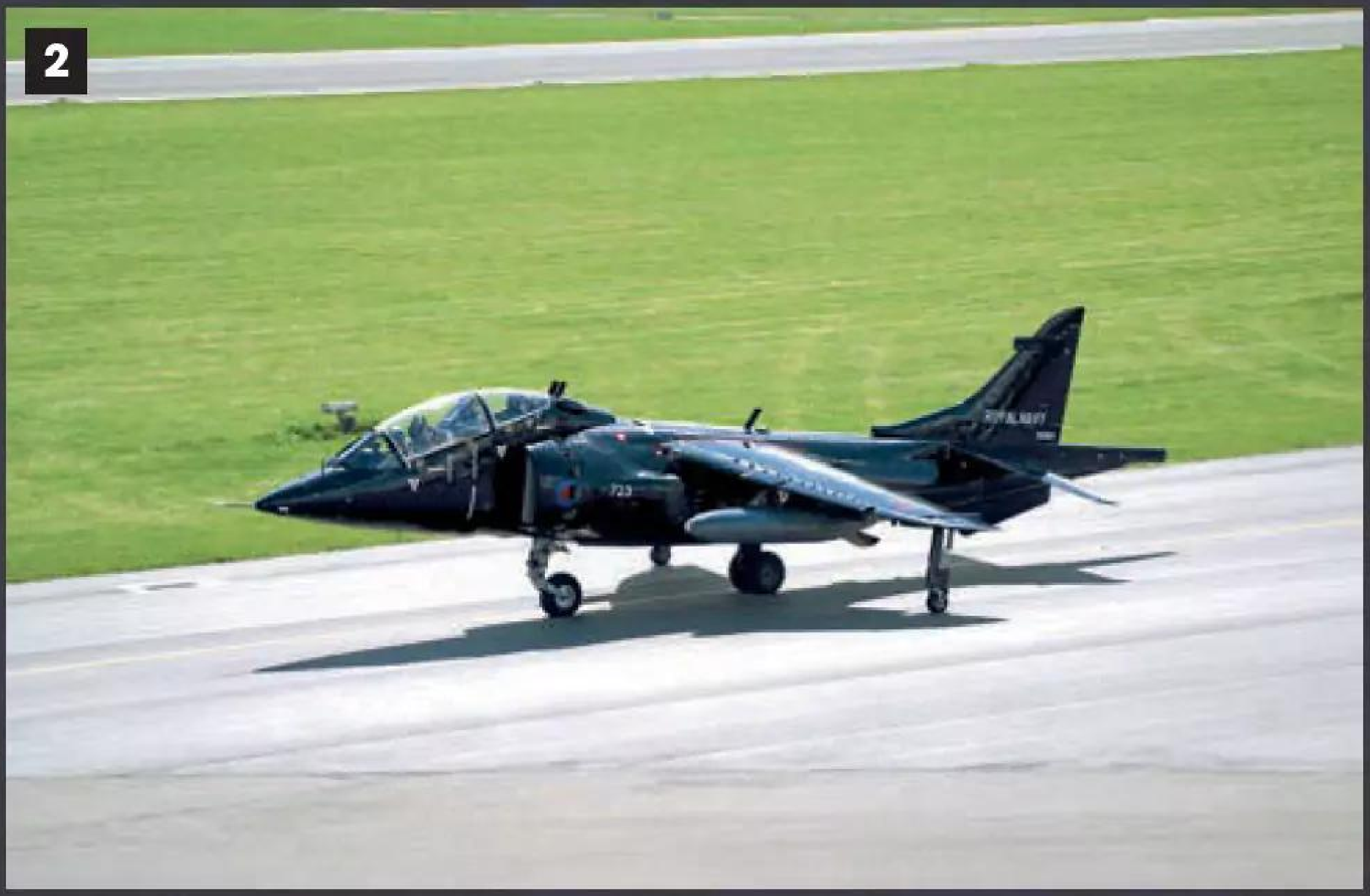
With the introduction into service of the Sea Harrier FA.2, these three aircraft, and two additional T.4s acquired from the RAF, were converted to T.8 standard, flying for the first time in 1994. These aircraft had modified cockpits to better emulate the layout of the FA.2, again without the Blue Vixen radar, and were powered by the improved Pegasus 11 Mk106 with 21,500lb (9752kg) thrust. Similarly, the RAF had planned to upgrade the T.4As to a new standard known as the T.6 to act as a trainer for the new Harrier GR.5. When it was fully understood just how different the new aircraft was from the earlier Harriers, this project was shelved in favour of a two-seat version of the Harrier II, called the T.10.

The US Marine Corps Harrier training squadron, VMAT-203, operated eight TAV-8As between 1975 and 1987, these aircraft being analogous to the RAF's T.4, but without the LRMTS nose and the RWR tail.

1

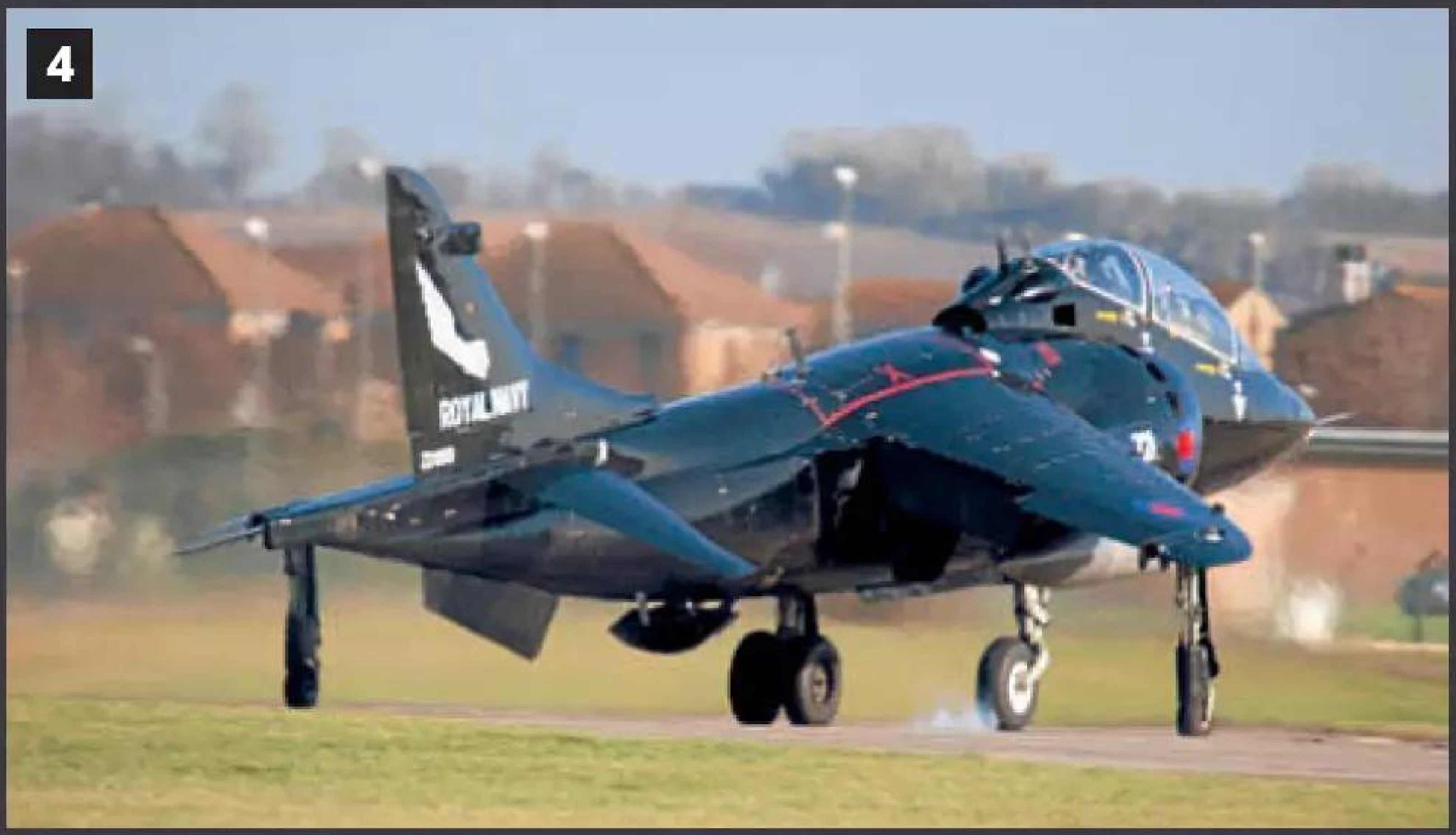


2

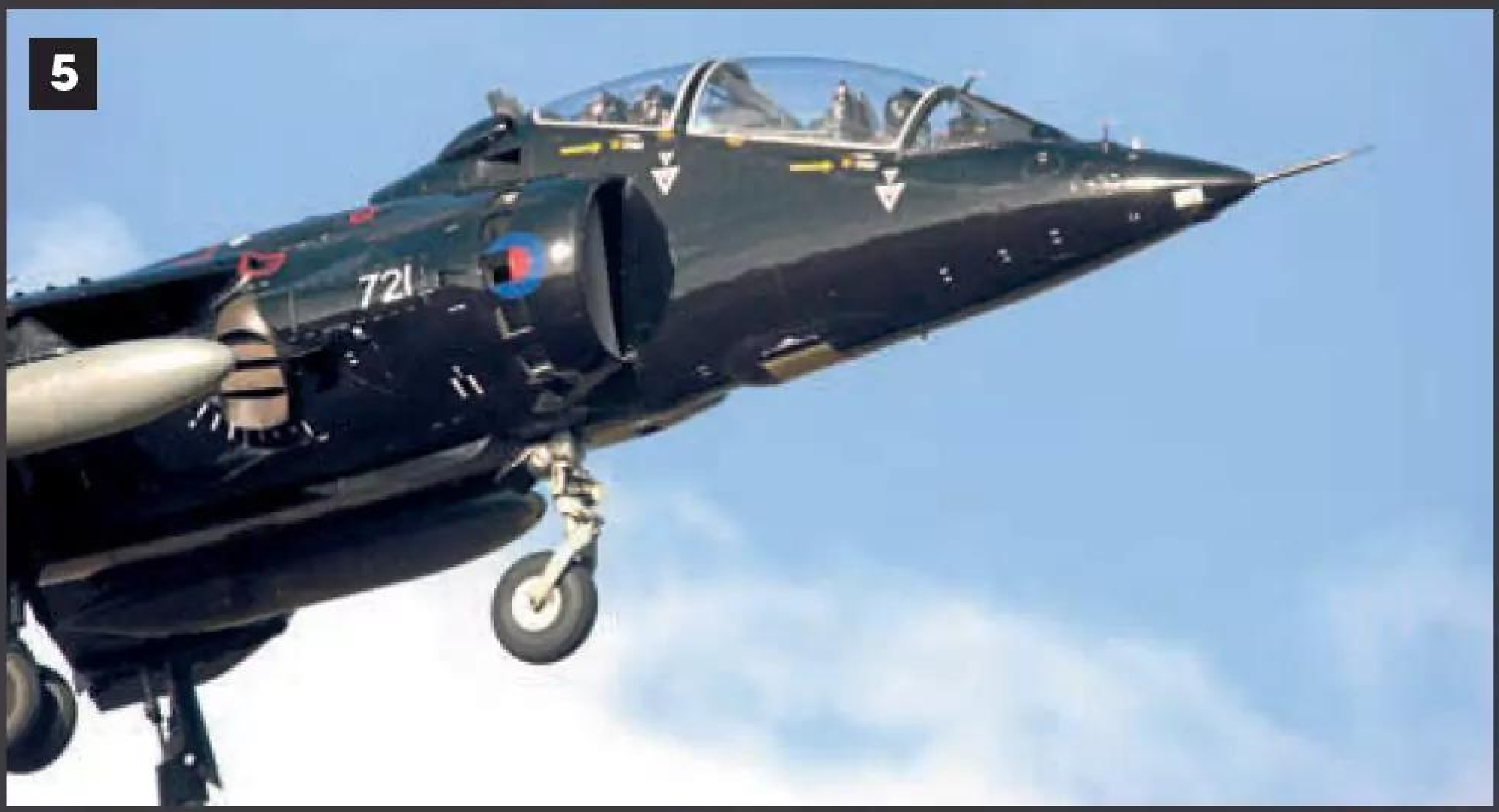


3

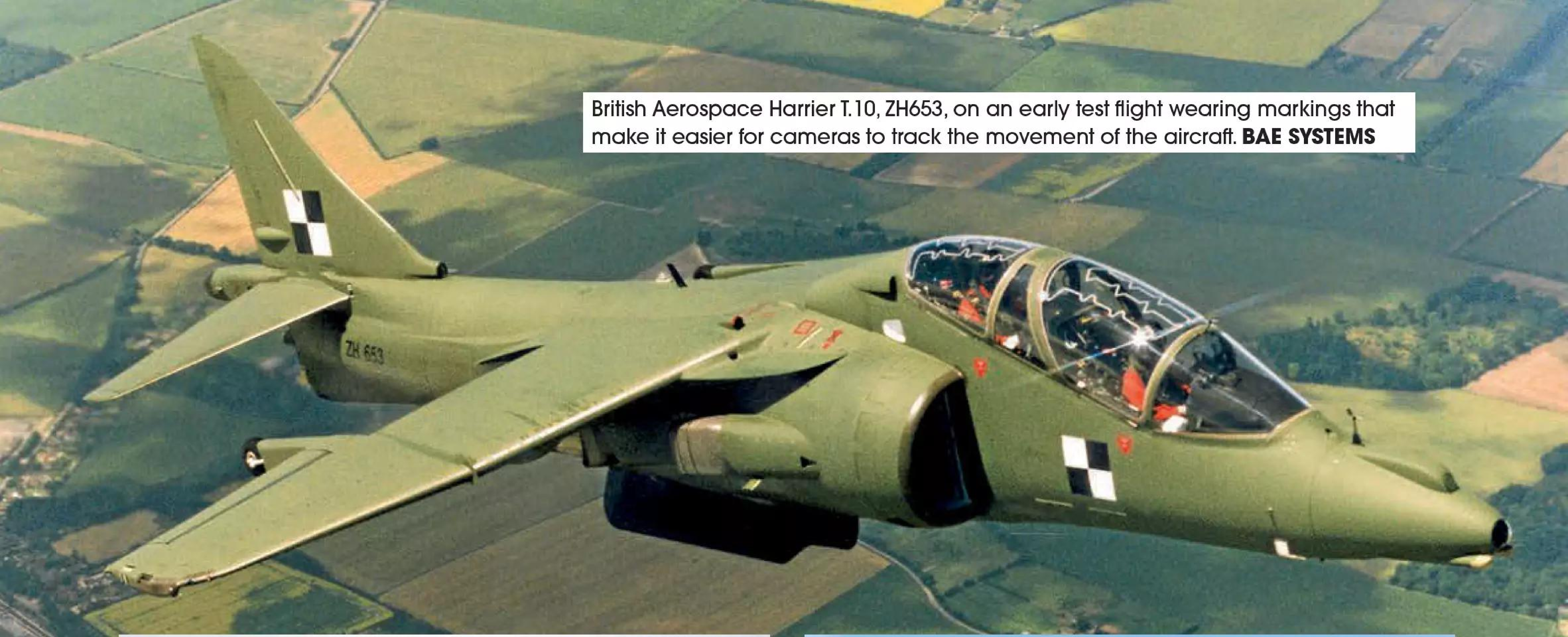
4



5



1. The Hawker Siddeley Harrier T.2 demonstrator, seen at the Paris Air Show. Note the fin extension on this aircraft. **BAE SYSTEMS**
2. A Hawker Siddeley Harrier T.8 of the Royal Navy taxies out at RAF Waddington during an exercise in 2003. **Joe Walsh**
3. A Hawker Siddeley Harrier T.8 of 899 NAS. **Keith Draycott**
4. A Hawker Siddeley Harrier T.8 of 899 NAS showing the lengthened tailcone and repositioned fin necessary to balance the front cockpit. **Keith Draycott**
5. A Hawker Siddeley Harrier T.8 of 899 NAS in the hover with the intake suction relief doors open. **Keith Draycott**



British Aerospace Harrier T.10, ZH653, on an early test flight wearing markings that make it easier for cameras to track the movement of the aircraft. **BAE SYSTEMS**

British Aerospace Harrier T.10, ZH660/P of 20 (Reserve) Squadron, based at Wittering, Cambridgeshire, pictured during a low-level training flight through Dunmail Rise in the Lake District on September 13, 1996. **BAE SYSTEMS**

Formation of three British Aerospace Harrier T.10 two-seat trainers flown by 20 Squadron based at Wittering, Cambridgeshire. **BAE SYSTEMS**

One of the two TAV-8Bs built to Harrier II Plus standard for the Italian Navy. **Keith Draycott**

A British Aerospace Harrier T.10, ZH661, of 20(R) Squadron, the Harrier OCU, over Wainfleet bombing and gunner range in 2006. **Keith Draycott**

Like the RAF, the advent of the AV-8B in USMC service with its completely different digital cockpit, larger wing and different handling prompted the development of a two-seat version of the new type, known as the TAV-8B.

The improved aerodynamics of the AV-8B meant that the tail did not have to be quite so modified, as had been the case with the earlier trainers, in order to balance the twoseat cockpit which lengthened the nose by the same 47 inches (1.2m) as on the earlier types. On the AV-8B, the fin was increased in height by 17 inches (0.43m) and is of slight broader chord as a result, giving the required directional stability.

Jackie Jackson first flew the prototype on October 21, 1986, and the first production aircraft, 162963, was delivered to VMAT-203 on July 24, 1987. The cockpit was identical to that of the single seater, but the TAV-8B was not fully combat capable, as it only had two underwing pylons for the carriage of drop tanks or practice weapons.

The first 23 TAV-8Bs built, 22 for the USMC and one for the Spanish Navy, had the Pegasus 11 Mk106 with 21,500lb (9752kg) thrust. Two later aircraft built to Harrier II Plus standard but without the radar were delivered to the Italian Navy and powered by the Pegasus 11-61 or F402-RR-408 of 23,800lb (10,795kg) thrust.

The Harrier T.10 for the RAF was similar to the TAV-8B with one major exception, it retained the eight underwing pylons of the GR.5 and was fitted with the same FLIR system, making it fully combat capable. Powered by the Pegasus 11-21 Mk106 of 21,750lb (9866kg) thrust, the first of 13 T.10s built for the RAF made its maiden flight on April 7, 1994, and entered service with 20(R) Squadron, the Harrier OCU, on March 1, 1995. The last trainer version, the T.12, was a conversion of the T.10 to the same weapons, avionics and software standard of the GR.9. Twelve aircraft were converted to T.12 standard between 2003 and 2006. ■ *Words: Tim Callaway*

Marine AV-8Bs over Iraq

Operation Iraqi Freedom

The Marine Harriers were tasked with daily patrols over the city of Baghdad. This VMA-311 was flying patrol when the ground troops were trying to rid the city of insurgents and were ready if the call for help came. **Brad Gering**

The Pentagon realised what a formidable asset the AV-8B Harrier was when the Marines sent them into Desert Storm and eventually six of them into Afghanistan as part of Operation Enduring Freedom (OEF).

At this time, the corps had several squadrons of Harriers based on both the west and east coasts in the US. Each of these units was well versed in close air support and interdiction and the hours of darkness did nothing to diminish their effectiveness.

In late 2002, as the situation worsened in Iraq, plans were made to deploy several of these squadrons to the Middle East in an effort to rid Iraq of Saddam Hussein and his Republican Guard.

The Marine Harriers would play a key role in a huge military offensive that would be known as Operation Iraqi Freedom. Marine records on this deployment state that a total of 60 AV-8Bs would deploy on amphibious carrier-type ships and another 16 of them would be land based (VMA-214). Their mission was strictly precision strikes and close air support. They were also given the task of Armed and Aerial Reconnaissance whether in daytime, night or under adverse weather conditions.

The latter put a heavy price on enemy ground movements at night. The fact that the Harriers could effectively operate on ships, roads or land bases made them a favourite among the ground troops. They were never expected to be used in the air superiority role as the F-15 Eagles dominated that role with outstanding results.

One of the Wake Island Avengers VMA-211 Harriers launches from the USS *Bonhomme Richard* for a mission over Iraq. They were very effective in the ground support missions protecting the advancing troops. **Brad Gering**

The 'Black Sheep' from VMA-214 would utilise the airfield at Ahmed Al Jaber in Kuwait. This base enhanced the VTOL operation because it allowed the ship-based squadrons to hit targets in Iraq, recover at Al Jaber to refuel and re-arm where they would fly another mission and finally recover on their assigned carriers. This doubled the sortie generation rate and it also served to cut in half the workload and ordnance usage on the carriers.

This also cut down on the number of times that the ships had to be re-supplied with ordnance and aviation fuel. There was a shortage of suitable airbases in the Middle East with all the airpower that had flooded in, so using the small carriers was ideal for the VTOL operations. Each of these multi-purpose amphibious carriers would carry a combination of Harriers and helicopters.

The mobility of these ships allowed the Marine squadrons to respond to any situation without having to fly extremely long missions and response time to calls from the ground for help was critical.

Harriers from VMA-542 are lined up on the deck of the USS *Bataan*. Two of them were assigned to a sister squadron; VMA-223. **Travis Wells**

One of VMA-211's Harriers takes off from the USS *Bonhomme Richard* (LHD-6) for a close air support mission somewhere off the coast of Iraq. **USMC**

This airborne AV-8B still has its LAU-10 rocket pod intact as it waits to be called in on more targets. The pod held four 12.7cm Zuni rockets. This Harrier was assigned to VMA-223. **USMC**

The USS *Bataan* (LHD-5) was home base for both VMA-223 and VMA-542 during OIF. The Bulldogs from 223 had initially done time over Afghanistan before moving into the Iraqi theatre of operations. **M. L. Hunting**

The USS *Bonhomme Richard* (LHD-6), aka 'the BHR', would be the home base of operations for both VMA-211's Wake Island Avengers' and VMA-311 'Tomcats'. They would be part of Amphibious Task Force West that would operate from the northern Persian Gulf.

BULLDOGS AND TIGERS

The USS *Bataan* (LHD-5) would provide a base of operations for VMA-223's 'Bulldog' and VMA-542's 'Tigers'. The Bulldogs had arrived in theatre on the USS *Kearsarge* but cross decked over to the USS *Bataan*. Early on in the combat operations, 223 passed the 50,000 mishap-free flight hour mark. The USS *Nassau* (LHA-4) and the USS *Tarawa* (LHA-1) were also major contributors in the Harrier's presence. Each of the latter two deployed with six AV-8Bs on board that were under direct operational control of MAG-13.

The Marines were already aware of what a handful of these aircraft could do, as they had already made their mark in Afghanistan.

Of course, the training regimen that the pilots had to go through gave them an edge and the experience to use their aircraft to the maximum. But, there was another factor which gave it the edge and that was the Northrop Grumman Litening II targeting pods (L-Pods).

Captain Tom Hodge was a seasoned intelligence officer for MAG-13. According to his commanding officer: "His expertise saved the lives of countless marines on the ground." He added: "The LPods gave our AV-8Bs a huge advantage in terms of intelligence, surveillance and reconnaissance. This coupled with our theatre and national intelligence capabilities allowed us to prosecute Iraqi targets very effectively. Moreover, we had accurate Battle Damage Assessments (BDA) after each strike because our L-Pods captured everything on video.

"Strike Operations against the Iraqi Republican Guard Infantry Division (RGID) proved to be one of the most successful missions for MAG-13.

"Our Intel section located the only armoured battalion in that organisation and after receiving the 'go-ahead' from Colonel (Mark R) Savarese, destroyed every tank prior to the 1st Marine Division entering the city of Al-Kut. The 1st went through the Republican Guard unit like a hot knife through butter because all of their armour had been destroyed. Our intelligence section drove operations; actionable intelligence, pilot proficiency and lethal GBUs made MAG-13 the most effective fixed wing attack group in the Marine Corps during OIF."

While many of the Marine Harrier units arrived in the Middle East before OIF started in January 2003, they took the time to hone their skills over Afghanistan.

The USS *Bonhomme Richard*, carrying two squadrons, ran into some trouble en route to Iraq in that it had some boiler malfunctions causing the ship to divert to Guam for repairs which would only cause a three-day delay. Once underway again, it would waste no time in getting up to speed on night operations.

It initiated an intense regimen of night qualifications for the pilots, and by the time they got into combat they were ➤

well versed in night ops which would allow them to deal a devastating blow on any enemy attempts to move during the hours of darkness.

The importance of the Harriers having a fully equipped land base in Kuwait can never be overstated.

As the ground forces gained ground into Iraq, the forward operating bases were able to move closer – which in some cases put the force only about 100 miles (15 minutes' flying time) to Baghdad. These facilities opened up as early as April 4. This not only allowed a much longer loiter time over the front lines, but gave the AV-8Bs the ability to range deep into Iraq to take out enemy assets without having to rely on aerial refuelling.

Thus, the Harriers became the first coalition strike aircraft to sustain operations from newly captured airfields within Iraq. The biggest advantage of this was it allowed very quick response time to any ground action or 'friendlies' in trouble. In the worst cases they were only 15 minutes from the action as opposed to the response time from a base in Kuwait or from the carriers which could be as high as 45 minutes to two hours.

The Black Sheep from VMA-214 spent their tour operating from a land base in Kuwait with their 16 Harriers.

During the first full month of their combat operations, April 2003, they flew 480 sorties which totalled 654.8 hours in the air. However, during the first week of April they demonstrated the true potential of the AV-8B when they landed on a remote highway 60 miles south of Baghdad. Even though this area was not completely secured, this put them just minutes from the fighting, which increased their effectiveness.

A short time later, they established another first when they began refuelling and re-arming at a forward operating base at An Numaniyah. The key to this location was that it put them almost point blank with the city of Baghdad. As the troops entered it, being able to pinpoint a target became more difficult for any air support, so the Harriers had plenty of 'loiter time' over the area to make sure they could hit a hot spot and allow the 'friendlies' to advance.

Squadron historical data for April 2003 listed four significant events for the Black Sheep in OIF. On April 1 they dropped ordnance in support of the famous POW rescue operations near An Nasiriyah. The following day, they landed and refuelled at Sheik Hantush highway landing strip which is mentioned above. On April 4-6, they attacked and destroyed numerous Ba'ath Party headquarters buildings in Ad Diwaniyah. From April 10 through to the end of the month, they were involved in hot refuelling operations and strip alert at An Numaniyah which was a forward operating base.

Captain T. M. 'Marty' Bedell, a pilot with the Black Sheep, gave some insight into what was going on at that time: "One night we were covering a large convoy that included some tanks and armoured personnel carriers. The lead element had pushed far ahead and went through the waiting ambush with no shots fired, but as the main force entered that area, all hell broke loose.

"There was a wide gap between the main group and the lead element, so that generated a lot of confusion as the enemy started firing. One of our pilots was attached to that force acting as a forward air controller on the ground. At that time, I was in a twoship element patrolling over the Basra area where it was quiet, so we headed over to a designated 'kill box'. As we were enroute we heard, over the guard frequency, our guy on the ground radioing for any aircraft in the vicinity to get over and help them out because they were being overrun by the enemy. This drew a quick response from any of our guys that were up on patrol and my element was the first to arrive overhead."

NIGHT OPERATIONS

All of the Harrier pilots flying night missions had the night vision goggles (NVGs) which made it easy for them to pick out targets on the ground. When Cpt Bedell arrived over the ambush, he could see tracers going in two opposite directions. Unfortunately, he and his wingman had been on patrol for quite some time and they were only minutes from bingo fuel (the level at which a safe return to base can be guaranteed), so they didn't get a chance to drop their ordnance but they were able to determine where the 'bad guys' were and where the 'friendlies' were. As they pulled out to refuel, they were able to give the aircraft converging on the area an accurate description of the enemy location.

"The wave of Harriers that arrived overhead was able to accurately drop their ordnance and it was due to the fact that one of them had the Litening II targeting pod and was able to take the grid coordinates and put his IR pointer on the target area," said Capt Bedell.

"This enabled all of the others with their NVGs to identify the marked target. With the IR marker out they would radio 'my mark, your control'. From there, the guys tracking it on the ground with their

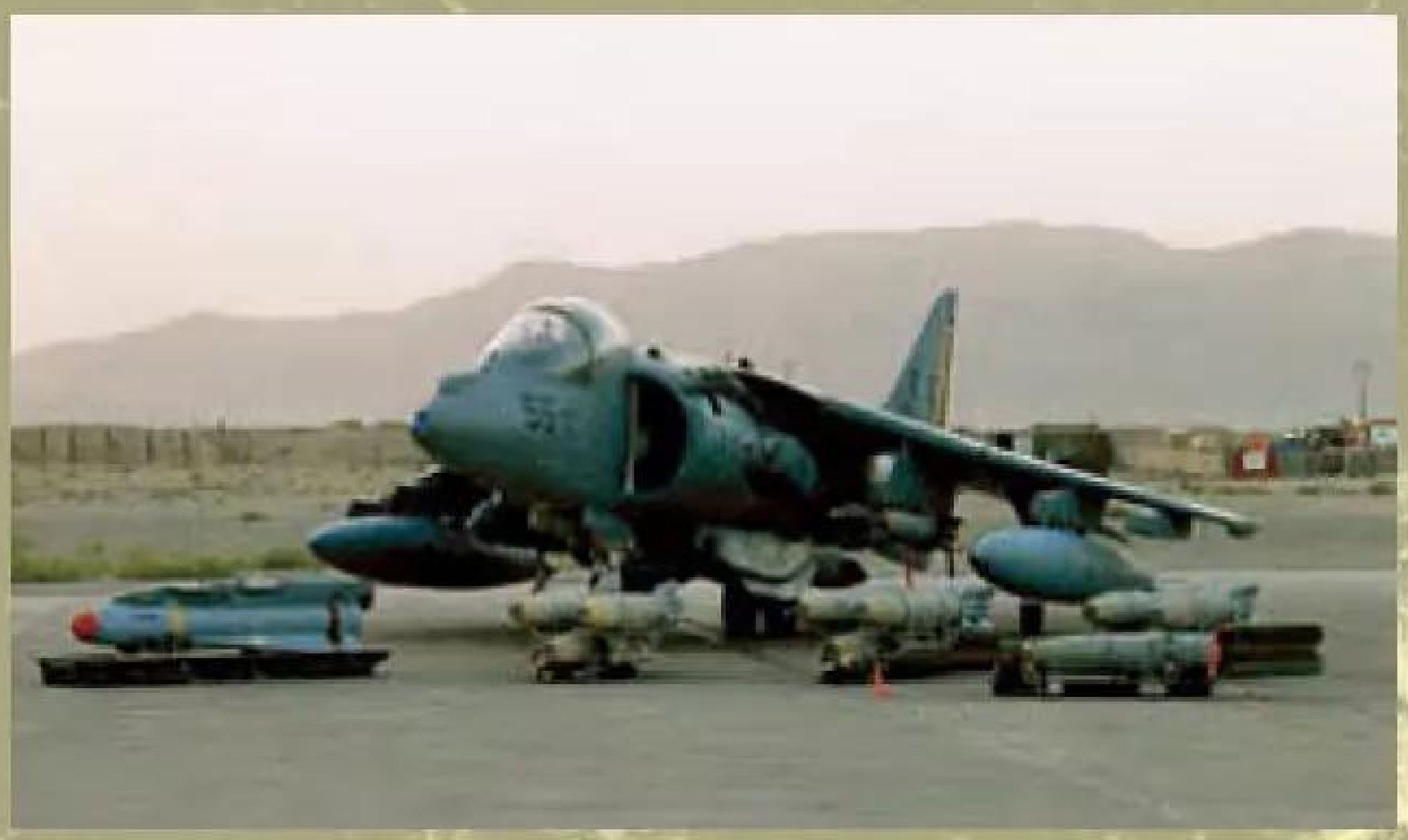
One of VMA-542's Harriers joins up with the tanker on a lengthy patrol mission over Iraq. The squadron also did some time over Afghanistan as part of OEF. These AV-8Bs had a long loiter time over any target area which was a great benefit to friendly troops on the ground. **USMC**

The AV-8B cockpit had a very sophisticated instrument panel as seen in this view. They could easily pinpoint targets on the ground at night from altitude. This Harrier was assigned to the Black Sheep of VMA-214. **Tyler Bardo**

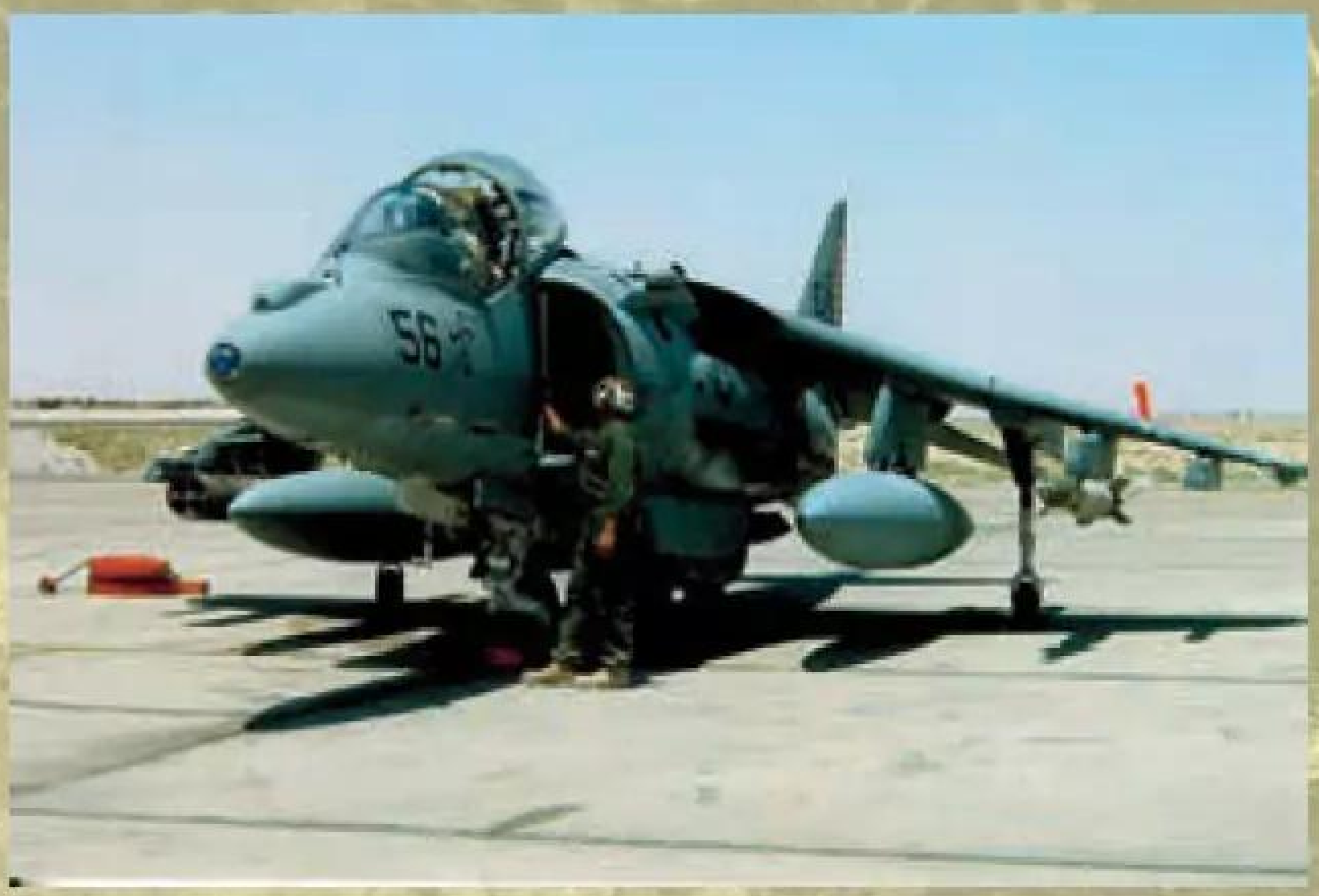
AV-8Bs on the deck of the USS *Bonhomme Richard* (LHD-6). In one active month over Iraq, the squadron flew 360 sorties that equated to 640 flight hours. **VMA-211**

The maintenance crews did an outstanding job in keeping the in-service rate up during their deployment in OIF. This VMA-311 Tomcat Harrier is undergoing major repairs below deck on the USS *Bonhomme Richard*. **USMC**

A VMA-311 Harrier looks for targets over Iraq on a lengthy patrol sortie. Note the Litening targeting pod on the starboard inside pylon. It allowed pinpoint accuracy at any time of the day or night. **Brad Gering**

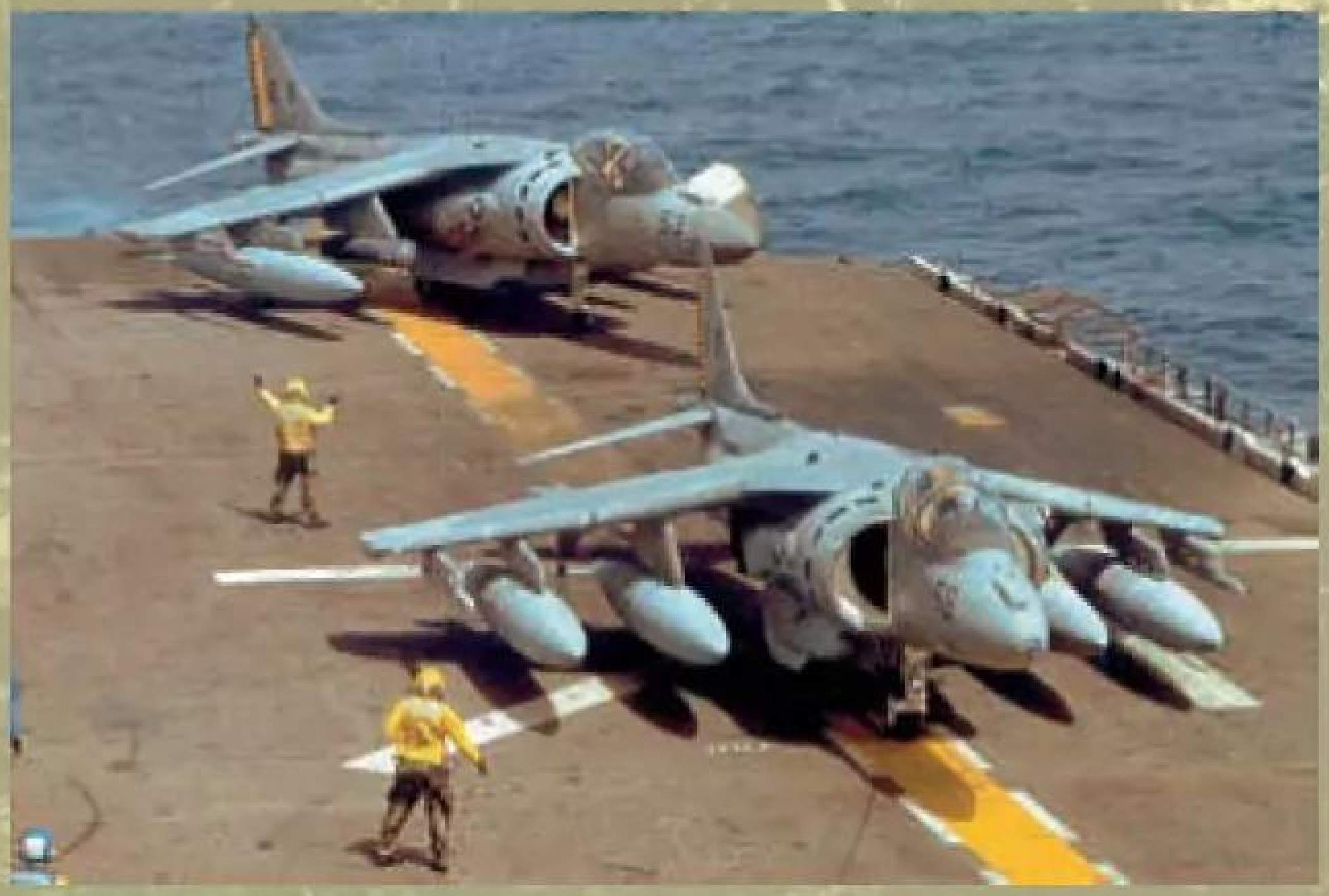


Many of the Marine Harrier squadrons used some land bases on a temporary basis. This was a photo op to show the variety of ordnance that the AV-8B could deliver. VMA-542 served in both Afghanistan (OEF) and Iraq (OIF). **Travis Wells**

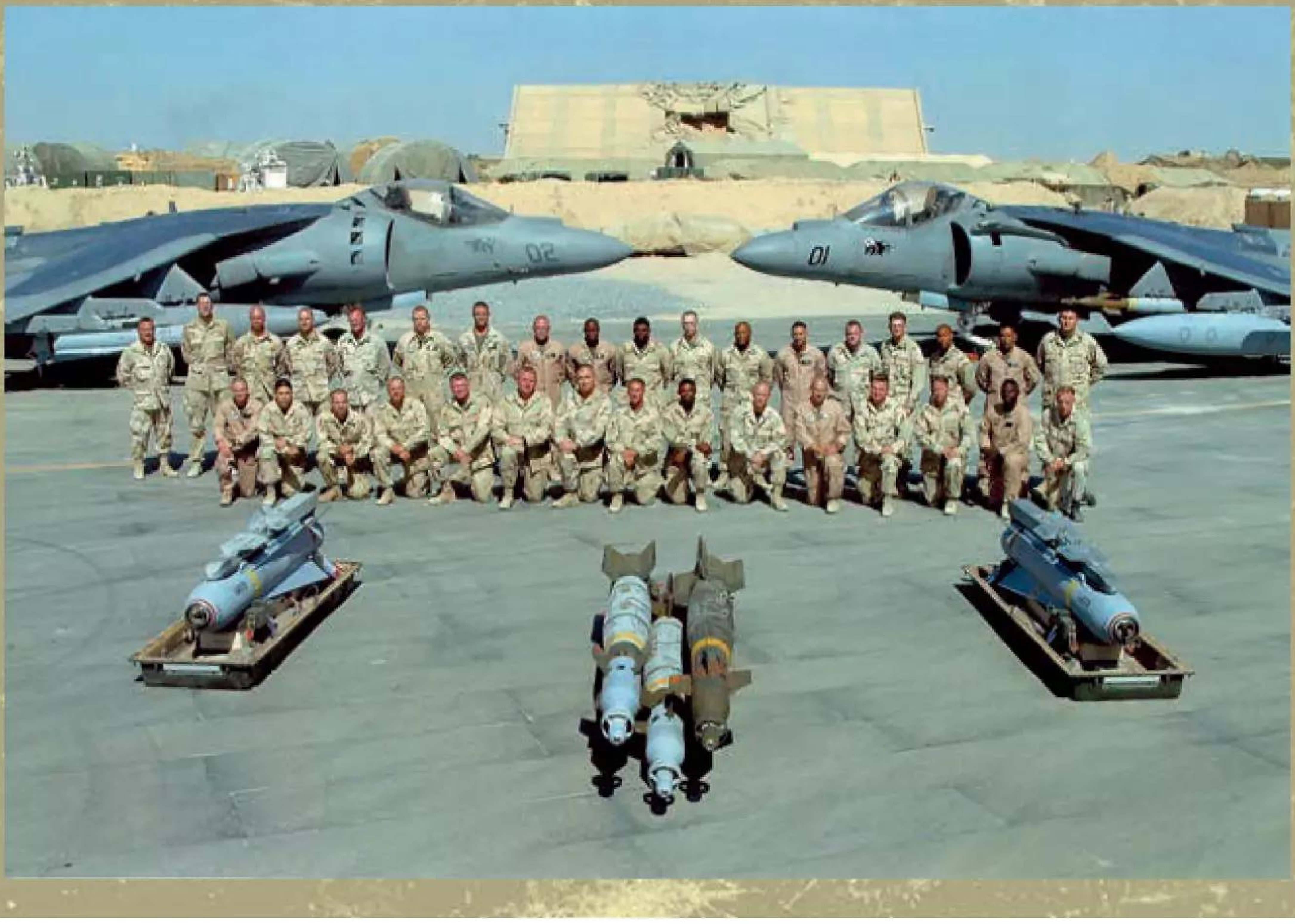


Marine Harriers frequently used airfields in Iraq to base their strikes from. This was taken at Al Numaniyah when VMA-542 was using it. The AV-8B is armed with a GBU-12 and a LAU-10 rocket pod. **Travis Wells**

VMA-223 pilots have manned their Harriers and are ready for the order to launch on another mission. They were operating from the USS *Bataan* (LHD-5) at the time. **M. L. Hunting**



Two Harriers assigned to VMA-542 move into position for take-off from the USS *Bataan* during OIF. **Travis Wells**



Right: VMA-214's Black Sheep flew to the Middle East from their base at MCAS Yuma, Arizona, using tanker support. They operated from Ahmed Al Jaber Airbase. Some of the squadron personnel pose by two of their aircraft and an assortment of ordnance. **Marty Bedell**

NVGs would tell them which way to move the marker 'west 200 metres', or 'go north 100 metres', etc ... so the guy on the ground was controlling the pilot's thumb via his radio as they moved the pointer around on the ground. The most important aspect of this was to make sure that your pointer is not marking the friendlies!"

This encounter had been very successful in that not a single Marine was lost down on the ground. The firefight lasted until dawn and at that time, the A-10 Warthogs and F/A-18s arrived with heavy ordnance and finished the pocket of enemy troops off. The body count exceeded 100 enemy dead and a large number of tanks destroyed. It had been a well-planned ambush and without close air support, the Marines would have taken a lot of casualties.

On March 21, 2003, the ground war was kicking into full swing and all of the Marine Harrier squadrons had a full work schedule. The Wake Island Avengers of VMA-211, operating from the USS *Bonhomme Richard*, were in the thick of it. Once they departed from their home base at MCAS Yuma, Arizona, it took 45 days to finally arrive in the Persian Gulf. At that point all of the squadron pilots were required to helicopter into Al Jaber airbase to be briefed on the rules of engagement (ROE). Once this was accomplished, the air war started two days later.

Squadron records state that during that early period most of the close air support missions were around Al Amarah and An Nasariyah. From that area, they moved on and concentrated on Al Basra.

There were several missions that they flew in support of British ground troops that were meeting heavy resistance along the Tigris River which was north of Al Basra. During this period, it was the relentless attacks by 211 that wiped out Iraq's 10th Armoured Division which had dug in near the Qalat Sikah Airfield. By the second week of the ground war, the advances made by the coalition forces was so rapid that the Harriers had to work closely with forward air controllers to make sure they didn't hit 'friendly' troops.

AL-KUT OFFENSIVE

The next objective for the Wake Island Avengers was to take on the elite Baghdad Infantry Division that was entrenched in AlKut Squadron records show that by the end of March 2003, VMA-211 had posted a total of 302 flight hours which equalled 187 combat sorties. Their aggressive tactics and skills had saved countless lives of both American and British troops.

VMA-211's sister squadron on the USS *Bonhomme Richard* was VMA-311. They were very proficient in night operations with their Litening II targeting pods. Their first major foray into this realm was on the night of March 21, when they launched 18 sorties, most of which were in rough weather and low visibility. During that week, there was a lot of enemy activity on the ground after dark.

The first to take off was a two-ship lead by the squadron CO, Lieutenant Colonel Michael Hile, and his wingman Captain Jason Duncan. Their first assignment was to bomb the Alamo Bridge which was 30 nautical miles west of Al Basra. On that night, the weather was unusually bad and even with the targeting pod they could not achieve a clear view of the bridge, forcing them to return to the carrier with ordnance intact.

Another element of two Harriers that had launched later that night was assigned to the same bridge and fortunately the weather had begun to clear. At 0515 they were over the target and their pod was able to lock on. They unleashed one GBU-16 and two GBU-12s which hit dead centre. This became the first major target the squadron destroyed at night in bad weather. Most of the weather front had moved on by this ➤

EXPLOSIVE
ORDNANCE

The ordnance crews in all of the Marine Harrier squadrons put in long hours in an effort to keep their aircraft loaded with bombs and rockets. This scene was on the deck of the USS *Bonhomme Richard* on the flightline of VMA-211's Wake Island Avengers. **Brad Gering**

Colonel Mark Savarese was the commanding officer of MAG-13 during Operation Iraqi Freedom. This was taken on the USS *Bonhomme Richard*, prior to his climbing into the cockpit for a mission. **Mark Savarese**

time and the low visibility was due mainly to haze, dust and smoke from the burning oil trenches.

On March 23, VMA-311 was also tasked with working the areas in and around Basra. While many of the squadron's night missions went well with good results, the weather was a factor along with fuel consumption and this caused a few to be frustrating. Cpt Anderson and his wingman Cpt Whalen were flying their first night mission (armed reconnaissance) over in the southern kill boxes as Redbud 73.

Capt Anderson recalls the mission to the squadron historian: "A flight of F/A-18 Hornets was already working the area and asked us to remain above 18,000 feet until they finished. The weather wasn't perfect as all of us were trying to work a small area that was clear due to many broken clouds in the vicinity. Unfortunately for us, the Hornets must have just arrived on station when we got there because by the time they were finished, we were getting low on fuel. During our holding south of Basra, Cpt Whalen saw a couple of large calibre Triple-A firing rounds that were coming up right between the two of us. We were too low on fuel to try to go down and hit them, so we quickly exited the area. Evidently, the Hornets had stirred them up. It was a frustrating first night mission, but there would be better ones in the days to come."

A few nights later, the Tomcats were still looking for anything to hit and their luck was good on some nights and bad on others. They launched another four-ship and headed toward an area in and around An Nasiriyah. Breaking off into two ship elements working a safe distance apart, they received target coordinates enroute to the kill boxes and discovered a huge assortment of tanks, fuel storage trucks and white ammunition bunkers. However, the nasty weather started to roll into their area from the north which made run-in headings restricted.

The pilot of this VMA-311 Harrier gets the launch command from the deck hand on the USS *Bonhomme Richard*. **Brad Gering**

Two of the Harriers were running attacks from north to south while the other two were coming in from the south, guiding their GBUs under the clouds before their lasers were obscured. One of the pilots in the division released two GBU-12s which were guided into two separate ammo storage facilities – these immediately exploded into massive fireballs (secondary explosions) that they described as looking like Roman Candles going off. The bunkers were quickly obliterated.

As another Harrier released a GBU-16 toward an Iraqi tank, the haze broke the LPod lock and the target was barely missed. This type of pressure from the Harriers was kept on the Iraqi ground forces every night and by the middle of April they had taken a heavy toll of valuable enemy assets.

During the height of combat operations for 311 they were provided with enough target data to fly 18-20 sorties each day. Most of their efforts involved targeting the Republican Guard in and around Baghdad, including the Iraqi 10th Armoured Division.

VMA-542's Tigers, home based at MCAS Cherry Point, North Carolina, had an outstanding history as did most of the other marine squadrons – they flew night missions during the Second World War and Korean War, and they operated the F7F-3N Tigercat also on night missions over North Korea. Squadron records show that prior to their deployment they had gone through an intensive training programme that focused on carrier qualifications, air-to-ground combat and night systems training.

During this three-week period they dropped more than 200,000lb of ordnance with each pilot gaining experience with the GBUs, cluster munitions, rockets and dropping Mark-82s. This regimen was accomplished with each pilot getting a minimum of 20 hours' flying time in both day and night operations. This type of experience was probably accomplished with every Harrier squadron that would deploy in OIF.

VMA-542 responded to orders to deploy in OIF in 72 hours with all equipment and aircraft. Its OIF tour began on the USS *Bataan* while conducting expeditionary operations some 300 nautical miles deep in Iraq. With the help of KC-130 tankers and the ability to refuel and rearm at Al Jaber, Kuwait, the aircraft were able to strike targets as far north as Al Kut. When they finished that initial combat stint, they had logged over 1000 flight hours and dropped more than 170,000lb of ordnance. They also conducted over 750 safe and on-time take offs and landings from L-Class ships in both daytime and nighttime operations. The squadron finished their tour and brought all personnel and aircraft home safely.

CLOSE AIR SUPPORT

MAG-13 was given the responsibility of providing close air support 24/7 for the 1st Marine Expeditionary Force. In order to pull this off continuously and effectively, the Harrier Carrier concept was perfected and utilised. Full 24-hour coverage, using sustained aircraft utilisation rates and limited L-Class deck cycle time (10 operational hours) required the two carriers (USS *Bataan* and USS *Bonhomme Richard*) offsetting the two decks and overlapping the four-hour gap with the shore-based Harrier squadron (VMA-214) and the two remaining LHAs (USS *Tarawa* and USS *Nassau*).

The tactics experts determined that the initial sortie planning requirements called for a maximum of 136 sorties per 24-hour period. Both of the major Harrier carriers demonstrated the ability to execute 48 sorties during respective operational windows with the remaining sorties distributed among the two LHAs and VMA-214.

During the execution of this plan, the AV-8Bs provided more than 120 sorties over a 24-hour period when the ranges were

On many of the longer-range missions into Iraq, the Harriers depended on aerial tankers such as this Tristar which was flown by the Royal Air Force. **USMC**

Harriers from VMA-311 prepare to launch for a mission over Iraq. Note the lead AV-8B has the Litening Targeting Pod on the starboard pylon. The squadron flew their first combat sortie in OIF on March 21, 2003. **Brad Gering**

There were many occasions where the ordnance crews were having a tough time keeping up with the demands for re-arming the Marine AV-8Bs. These two pilots are helping get a large GBU loaded on one of the pylons. **Brad Gering**

This Iraqi automatic anti-aircraft weapon was extremely dangerous to low flying aircraft that were doing close air support and interdiction. It was captured intact by advancing troops. It could be moved quickly from one site to another. **USMC**

There were four main carriers that supported the Marine Harrier Operations in OIF; USS *Tarawa*, USS *Bataan*, USS *Nassau* and USS *Bonhomme Richard*. The AV-8B up front in the middle is equipped with the Litening Targeting Pod. The aircraft shown here were assigned to VMA-311. **Brad Gering**

within 180 nautical miles and over 70 sorties in the same period when the targets went out beyond Baghdad and as far north as Tikrit. By the middle of June 2003, the Iraqi war machine was crumbling. The Harrier squadrons were working around the clock in an effort to protect the troops that were now in close contact with the enemy in Baghdad.

Cpt Kyle Moore, flying with VMA-214, recalls a memorable mission that he flew during this period. It pertained to intelligence that some of the top Iraqi leadership was trying to escape: "It was very quiet during this period with very little activity on the roads at night. All of a sudden, here was this convoy heading toward the Syrian border. That ended up being one of the longest missions for us because we kept tanking up overhead. It was a very intense time because we were all going through the chain of command trying to find out if this group was worth going after.

"We ended up spending 5.5 hours in that area which was one of the high-time missions that our squadron flew. We continued to follow the convoy using our infrared capabilities and were finally relieved by another element of Harriers from our squadron. A short time later, that fresh element was allowed the engage and destroy the convoy. That order had to originate at the top because things had been so quiet. During that lengthy mission, we tanked four times. We were so far north (close to the Syrian border) which put us a long way from our home base.

"During my tour I was able to drop a lot of precision ordnance that destroyed tanks, artillery and ammo dumps etc. However, it was missions where we were working with a lot of people on the ground that I got the most satisfaction from."

The overwhelming success that the Marine Harriers had was partly due to the quality of the pilots, but most will tell you it was the Litening II Targeting Pods that made the difference, especially at night. When anyone discusses the AV-8B's exploits in Afghanistan or Iraq, they would have to give both versions of the targeting pod equal time.

Col Mark Savarese (MAG-13) said: "The Litening ISR Pod (ISR) stands for Intelligence, Surveillance and Reconnaissance. Actually, we employed two types of pods; the Litening II and the Litening ER. The difference between these two was the distinction in the number of pixels in the FLIR Litening II has a 25 x 256 FLIR and the ER version has a 640 x 512 FLIR for greater capability. Each pod features a forward-looking infrared camera; charge-coupled device television; laser spot tracker/range finder; IR marker and a laser designator. Northrop Grumman subsequently replaced the 256 FLIR (Litening II) with the latest technology 512 (the Litening ER) which has extended the target detection range."

THE LITENING POD

The concept and development of the target pod originated in Israel with the Rafael Advanced Defense Systems missile division in the early 1990s. The Israeli Air Force immediately embraced this new weapon.

In 1995 Northrop Grumman Corporation teamed up with Rafael and developed the Litening II pod that the US military quickly ordered it and began using and by October 2010 it had bought 1000 units. One of the major concerns with the coalition war planners was how many SAM missiles the Iraqis had and how to diminish any losses attributed to them.

The Harrier immediately had an advantage in that it could operate at night and stand off out of the SAM threat envelope allowing them to engage targets from a 'sanctuary' while still complying with the rules of engagement and positive identification (PID) criteria. The AV-8Bs, using these pods with their IR markers, were able to positively identify targets with ground units and airborne controllers at night which greatly reduced any chance of hitting friendly forces or inflicting casualties on civilians. They were also able to tape and document all of their missions which provided extremely accurate battle damage assessment (BDA) and intelligence information.

The Litening ISR Targeting Pod was incorporated into some of the Marine Harriers and it gave them all of the benefits of the ER pod and in addition they were able to provide real time video to ground units, increasing their situational ➤

awareness and aiding in time sensitive targeting (TST). This allowed the FACs on the ground to talk the Harriers on to targets that other aircraft types could not locate.

The ER pod was the only target system in the American arsenal to have the capability to send live video of exactly what the pilot was seeing to the troops on the ground. The Litening ISR pod provided real time intelligence during the rescue of a US Army POW Private First Class Jessica Lynch. It also gave the rescue forces a picture of what they would be facing as the rescue unfolded.

April 11, 2003 proved to be the final day that VMA-311 would drop bombs in OIF. On that date they would log 14 sorties. One of the most memorable of those was logged by Cpt 'Buzz' Anderson and Lt Col 'Jethro' Sexton. Cpt Anderson said: "Though I didn't know it at the time, my last OIF mission turned out to be one of the most gratifying. I was to lead the squadron Executive Officer, Lt Col Sexton, well north of Baghdad. As a bonus, he was carrying an AGM-65E laser guided Maverick missile. We didn't have very good intelligence going into this mission, but when we checked into the area, we were immediately given target coordinates and tasked to perform SCAR for a flight of RAF Tornados that were already on station. This was a daylight mission, so I was not worried about finding targets. Unfortunately, I could not find a single target in the area that we were sent to.

"A flight of F-15E Strike Eagles checked in, looking for me to provide some target info for them. Knowing they were more capable in spotting targets (they had a back seater), I passed that task on to them and they gladly accepted. They decided to work with the Tornados first because they were running low on fuel, while we held over to the east of their position.

"Three runs by the Brits had not completely destroyed the targets, so the Strike Eagles passed the latitude and longitude on to us that they suspected held some lucrative targets. We proceeded to the very north west corner of the kill box and found numerous vehicles in revetments. As we set up for our first attack, I found an Iraqi tank among the many vehicles and made a mental note of where it was in relation to a prominent landmark.

"We made our first run with the intention that Lt Col Sexton would fire the Maverick first. In the run, I counted revetments from the landmark to find the tank but I was too far away to verify that I had indeed captured the tank. Lt Col Sexton fired his Maverick and as I approached the tank materialised right in the middle of my crosshairs. However, even more quickly than it had appeared, it disappeared in a massive explosion of flying debris and smoke. When the dust finally settled, there was nothing left in the revetment which made me doubt whether or not I had actually chosen the correct one.

"We immediately set for another attack so that Lt Col Sexton could drop his GBU-12. However, a problem with his inertial navigation system (INS) caused him to drop short of the target. By this time we were getting low on fuel, so we made one more trip around the pattern so that I could drop my bomb. I picked out an armoured vehicle at the very last second and destroyed the last target engaged by VMA-311 during Operation Iraqi Freedom."

Lt Col Robert Claypool was the squadron commander of VMA-214.This was his assigned Harrier with all the bomb mission symbols painted on the fuselage. This was taken soon after they returned to MCAS Yuma from Iraq. **Author's collection**

When VMA-214 returned to their home base at Yuma, their aircraft had been flown hard in OIF and it was time to get them back in to top condition. This was the scene in the Black Sheep hanger soon after they returned from their combat deployment. **Author's collection**

HARRIER PROVEN

During the final days of April, the squadron would continue to fly armed patrols ... but there just weren't any viable targets to bomb. Finally, on May 3, Cpt 'Rudy' Whalen and Cpt 'Strut' Havener launched a two-ship over Baghdad and were tasked to fly a low altitude pass for a show of force in support of a downed helicopter. This would be the final OIF flight flown by VMA-311.

Records released by the 3rd Marine Air Wing stated a significant percentage of its air assets in Operation Iraqi Freedom were based on amphibious ships which speaks well of the importance of the AV-8B Harrier. Records also stated that when all of the missions were completed, not a single Harrier returned with bullet holes in it and none were lost in combat.

The mission capable readiness rates for the AV-8B was 80% or better, which is a credit to the dedication and expertise of the maintenance personnel. According to MAG-13 commander Col Savarese, the 3rd Marine Aircraft Wing utilised about 400 aircraft in that operation and most of these required the traditional airfields, but the Harriers were much more versatile as they could operate from roadways if they had to.

A Harrier returns to its carrier after expending its ordnance against Republican Guard positions in Iraq. **M. L. Hunting**

Colonel Savarese said: "During the 26 days of combat operations, we flew more than 2000 sorties which equated to about 3000 flight hours. Our Harriers expended more than 750,000lb of ordnance in support of the 1st Marine Expeditionary Force. This operation has to be proof of our Harriers' finest days."

In final figures released by the Marine Corps which involved the dates of March 20 through to April 20, 2003; 79% of the ordnance dropped were precision guided munitions with a total of 478 point targets destroyed (BDA positively confirmed) and no friendly fire incidents.

The last US-operated AV-8Bs were due to be retired in 2027. ■

Words: Warren E. Thompson

The Harrier Abroad

Overseas customers for the Harrier were surprisingly few and all the foreign air arms to operate the Harrier bought their aircraft through the United States with two exceptions.

With the exception of the British and US armed forces, who were partner countries in building the aircraft, there was little interest shown by other nations in ordering large numbers of the unique Harrier. However, several overseas customers were forthcoming, the largest order coming from the Indian Navy. Spain, Italy and Thailand also ordered both early- and late-model Harriers.

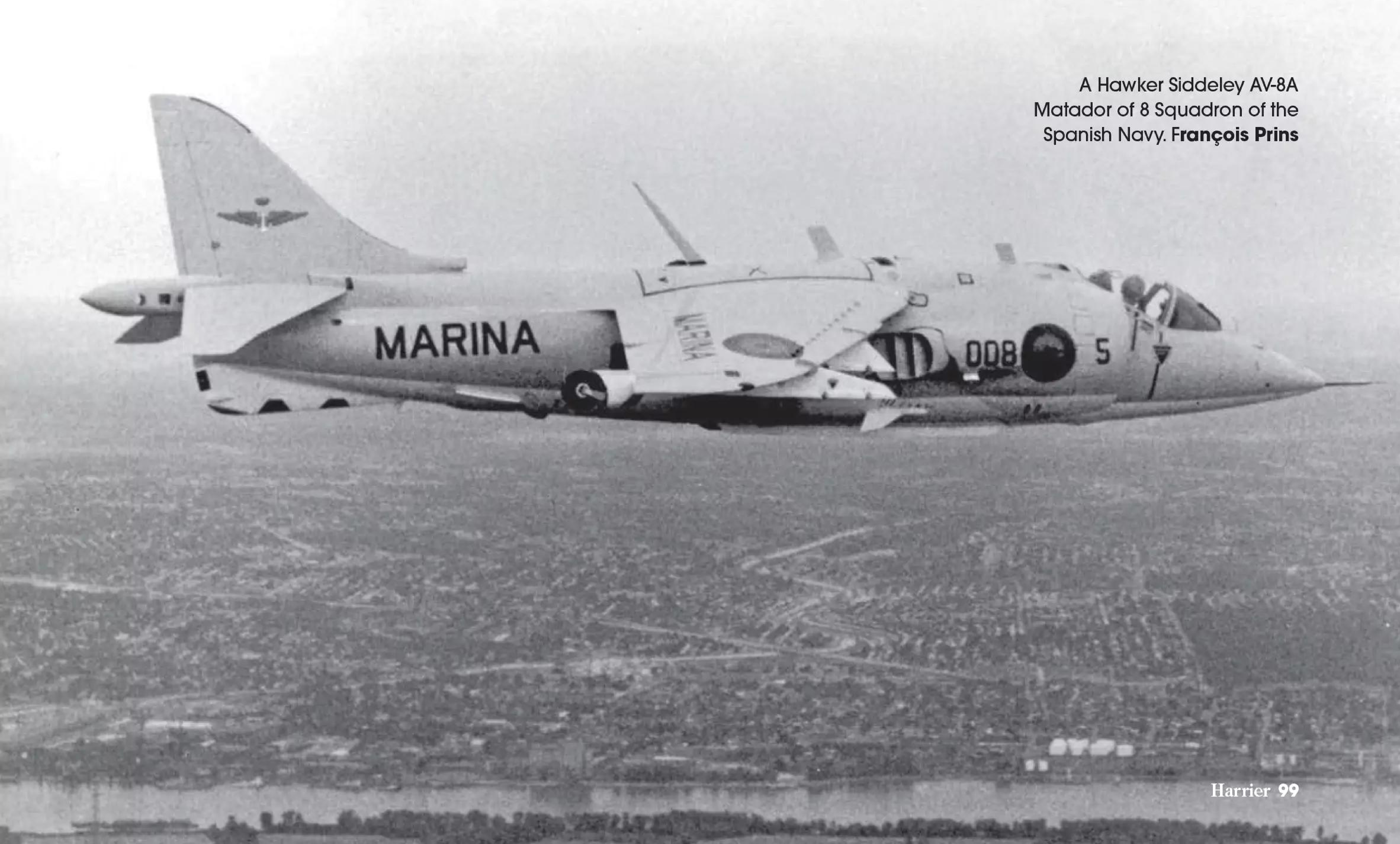
Aside from these countries, Hawker Siddeley did have expressions of interest from others, including Australia, Brazil, Switzerland, India and Japan. After the political thaw in East-West relations during the 1970s, the Chinese Air Force entered into negotiations, but this deal was quashed as part of the adverse reaction to China's invasion of Vietnam in 1979. Below are listed the countries who did buy the Harrier, and the types they purchased.

SPANISH NAVY

Spain's interest in the Harrier was complicated by long-standing political friction between the British and Spanish governments during the 1970s, particularly over issues such as Gibraltar. In order to complete the deal for six AV-8Ss and two TAV-8Ss, as the Spanish version of the Harrier AV-8A and TAV-8A were known, the aircraft were sold through the US, which acted as an intermediary to avoid any political entanglements or embarrassments. Both aircraft were powered by the Pegasus 11 Mk 150 with 21,500lb (9752kg) thrust and were equipped with mostly US avionics.

The aircraft were given the company designations of Harrier Mk.54 for the single seaters and Mk.58 for the two seaters by Hawker Siddeley, but known as the VA-1 and VAE-1 in Spain. They were built in Britain, then shipped to the McDonnell Douglas factory in St Louis to be assembled and delivered. Thus it appeared the deal was brokered between the US and Spain, and political honour was satisfied. In Spain, the aircraft were called Matadors and operated from the airfield at Rota and the aircraft carrier Dedalo, formerly the USS *Cabot* (CVL-58). In 1980 BAE sold a second batch of five single seaters directly to Spain without difficulty or political repercussion.

In March 1983, the Spanish Government signed an order with McDonnell Douglas for 12 AV-8Bs, making the country the first overseas customer for the Harrier II. The aircraft were powered by the Pegasus 11-21 Mk 152-42 with 21,450lb (9730kg) thrust and



A Hawker Siddeley AV-8A Matador of 8 Squadron of the Spanish Navy. **François Prins**

A McDonnell Douglas EAV-8B Harrier II Plus (Matador) of 9 Squadron of the Spanish Navy. **McDonnell Douglas**

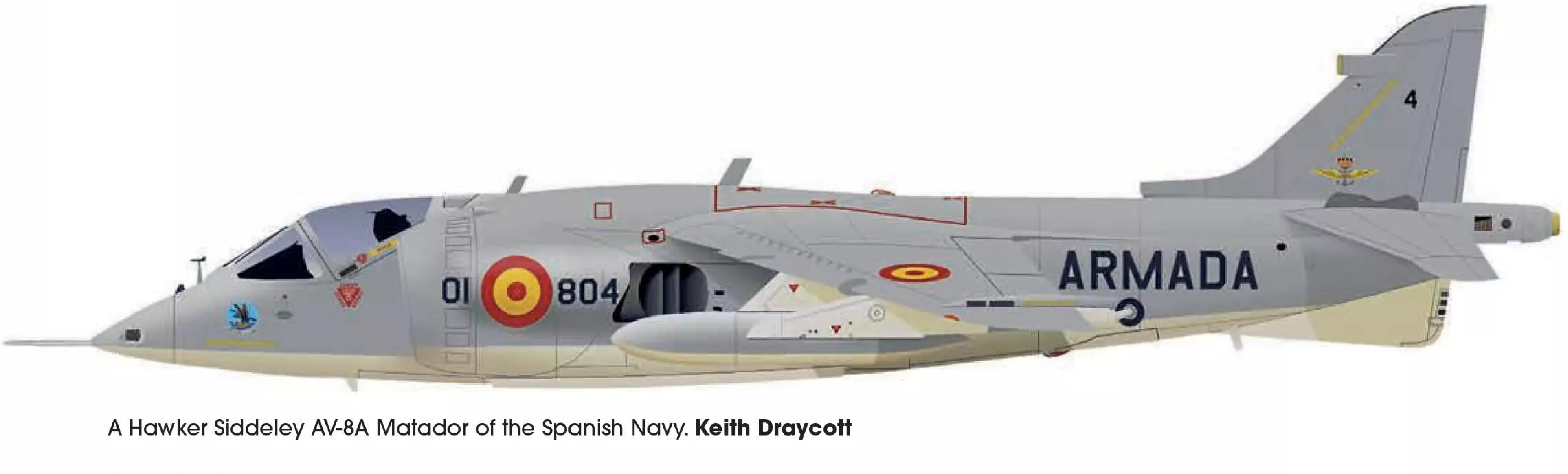
known as EAV-8Bs to the manufacturer but designated as VA-2 Matador II in Spain. The first aircraft were delivered on October 6, 1987, to the Naval Air Station at Rota and were purchased to serve on board the new Spanish aircraft carrier. Named the Principe de Asturias, this was fitted with a ski-jump and cleared for Harrier operations in July 1989, the Dedalo having been retired in 1988. The 12 EAV-8Bs were all allocated to 9a Escuadrilla which was formed on September 29, 1987, to become part of the Alpha Carrier Air Group.

In March 1993, Spain ordered eight more AV-8Bs, this time the Harrier II Plus radar-equipped version of the aircraft, as well as a single example of the TAV-8B two seat trainer. This contract was extended in 2000 when Boeing and the Naval Air Systems Command agreed to modify 11 of the original EAV-8Bs to Harrier II Plus standard with the addition of the radar, new avionics and an uprated engine. The new build and modified aircraft are both powered by the Pegasus 11-61 or F402-RR-408 of 23,800lb (10,795kg) thrust and can carry the AIM-120 AMRAAM air-to-air missile. The first new build aircraft were delivered to Rota in 1996 and later were deployed as part of the NATO forces participating in Operation Deny Flight over Bosnia and Herzegovina.

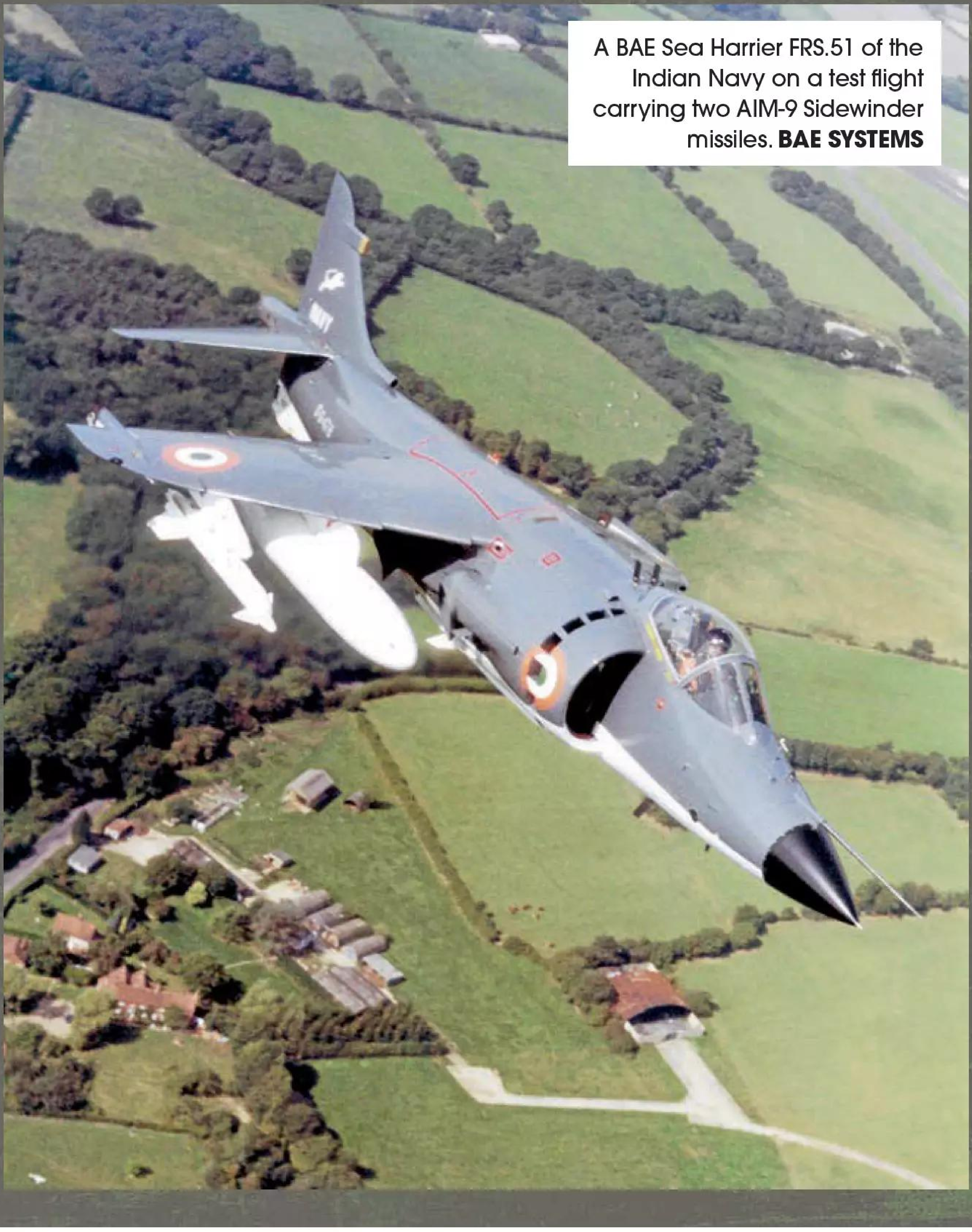
At the time of writing, Spain's AV-8B Plus Harriers were scheduled for retirement by 2030 – though the Spanish Navy was reportedly working to extend their service life still further.

ROYAL THAI NAVY

The Spanish Navy negotiated a deal with the Royal Thai Navy in 1992 for seven of its original fleet of single seat AV-8As and two of the two seat TAV-8As. The aircraft were operated from the light aircraft carrier HTMS *Chakri Naruebet*, which was built in

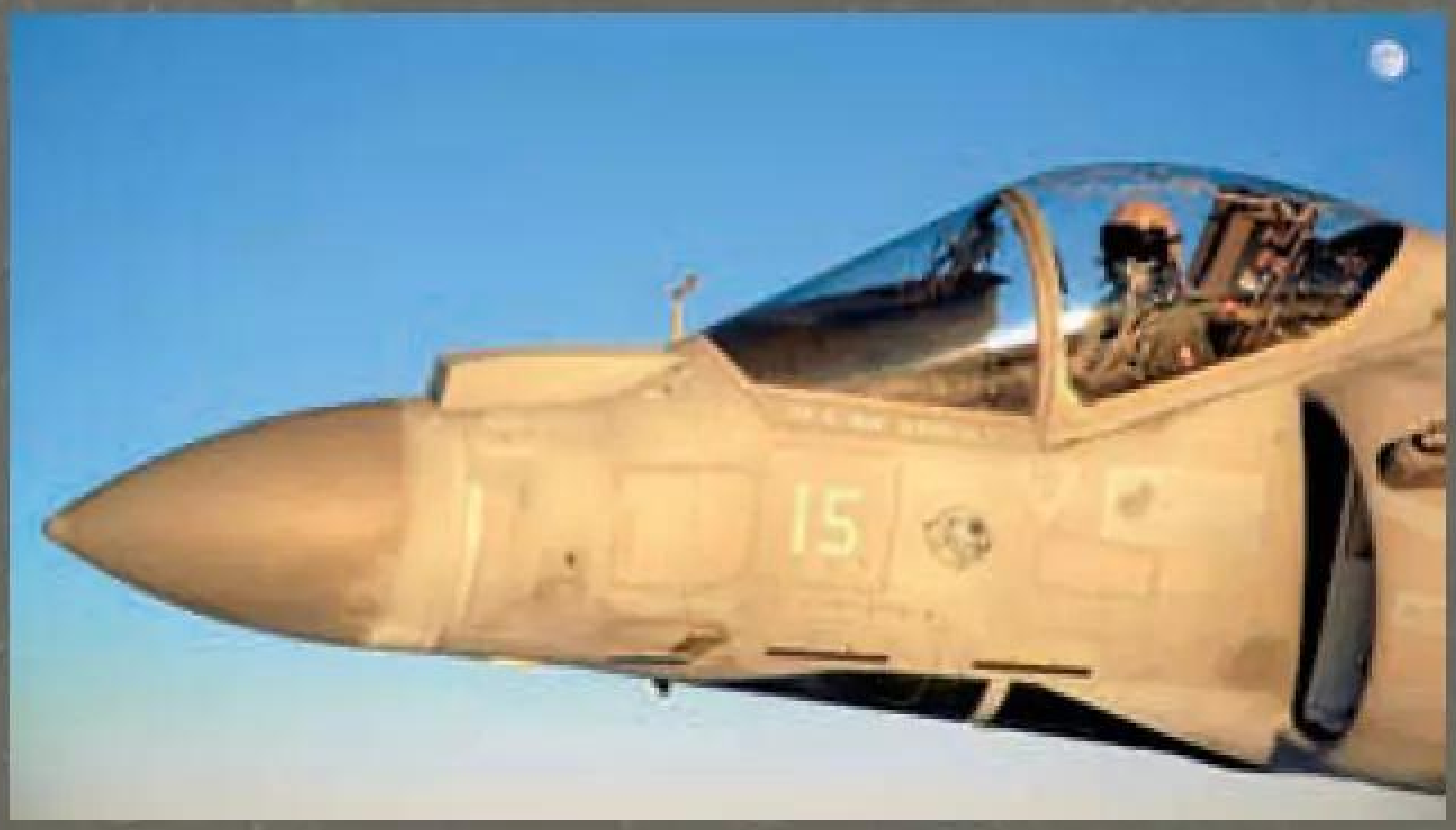


A Hawker Siddeley AV-8A Matador of the Spanish Navy. **Keith Draycott**


A BAE Sea Harrier FRS.51 of the Indian Navy on a test flight carrying two AIM-9 Sidewinder missiles. **BAE SYSTEMS**

A McDonnell Douglas EAV-8B Harrier II Plus (Matador) of the Spanish Navy at Waddington Air Show. **Keith Draycott**

A BAE Sea Harrier FRS.51 of the Indian Navy on a test flight from Dunsfold in 1983. Note the white tiger on the fin, the symbol of 300 NAS. **François Prins**


Close up of the cockpit of a McDonnell Douglas AV-8B Harrier II Plus of the Italian Navy. The fake cockpit canopy under the nose was to confuse opponents in air combat. **Luigino Caliaro**

Spain by IZAR and delivered in August 1997. The Thai Harrier pilots were trained in the US during 1995, then converted on to the AV-8A at Rota in Spain during 1996. The aircraft are all operated by 1 Squadron, part of the First Air Wing and are based at U-Tapao. In order to delay any problems with acquiring spares for the aircraft, as the same time as it purchased the Spanish aircraft, the Thai Government also bought a number of ex-US Marine Corps AV-8As from storage.

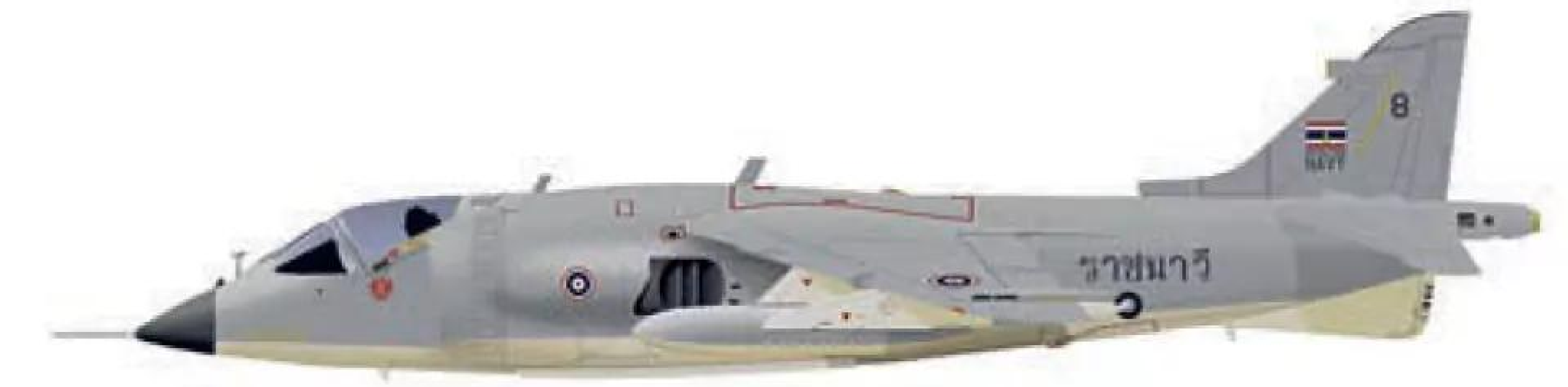
The entire fleet of nine Spanish aircraft were delivered during 1996 and 1997. The aircraft were no longer known as Matadors, the Thai Navy adopting the original name of Harrier. It was reported in 2006 that the Thai Harriers had all been retired from service.

INDIAN NAVY

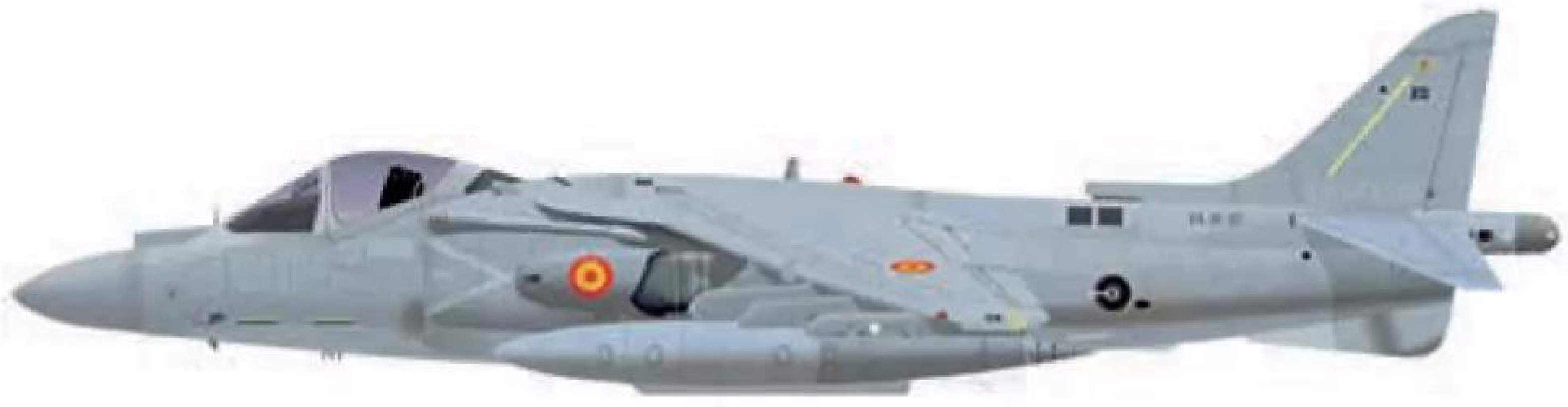
The Indian Navy was interested in the Sea Harrier to form the air wing of its aircraft carrier INS *Vikrant* (the former HMS *Hercules*). In 1983, six Sea Harrier FRS.51s and two Harrier T.60s were ordered, both powered by the Pegasus 11 Mk 151 with 21,500lb (9752kg) thrust. The FRS.51 was identical to the FRS.1 with the exception of some avionics and other detail changes, including the ability to fire the Matra Magic air-to-air missile. The T.60 was the equivalent of the RAF's Harrier T.4. The first three FRS.51s were delivered by a

One of the two McDonnell Douglas TAV-8B Harrier II Plus two seat trainers of the Italian Navy lands on the aircraft carrier Guiseppe Garibaldi. **Luigino Caliaro**

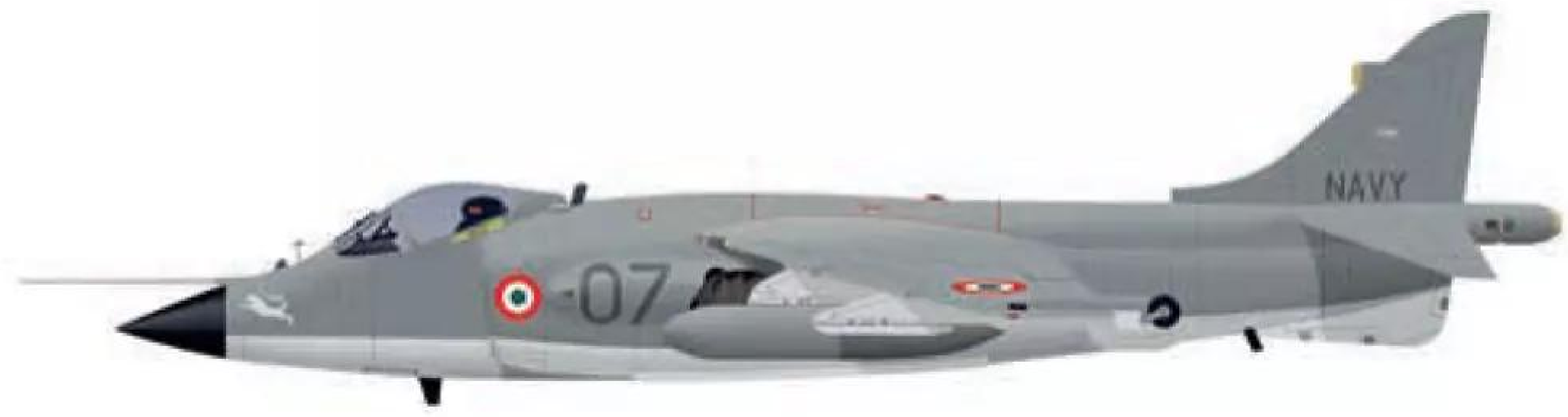
A McDonnell Douglas AV-8B Harrier II Plus of the Italian Navy lands on the Guiseppe Garibaldi. Note the wolf head insignia under the cockpit, the emblem of the Harrier unit Gruppo Aerei Imbarcati The Wolves. **Luigino Caliaro**



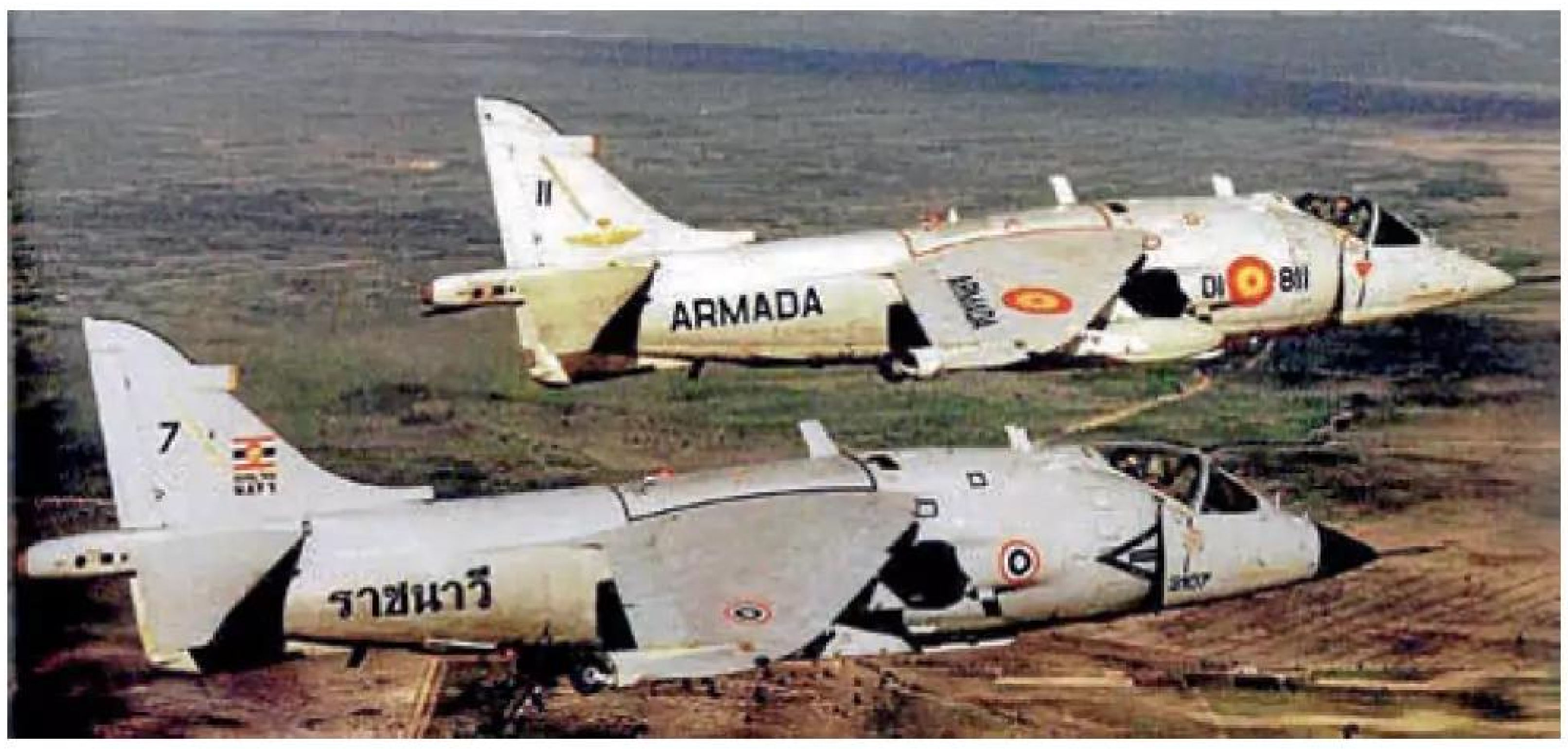
A Hawker Siddeley AV-8A Harrier of the Thai Navy. **Keith Draycott**



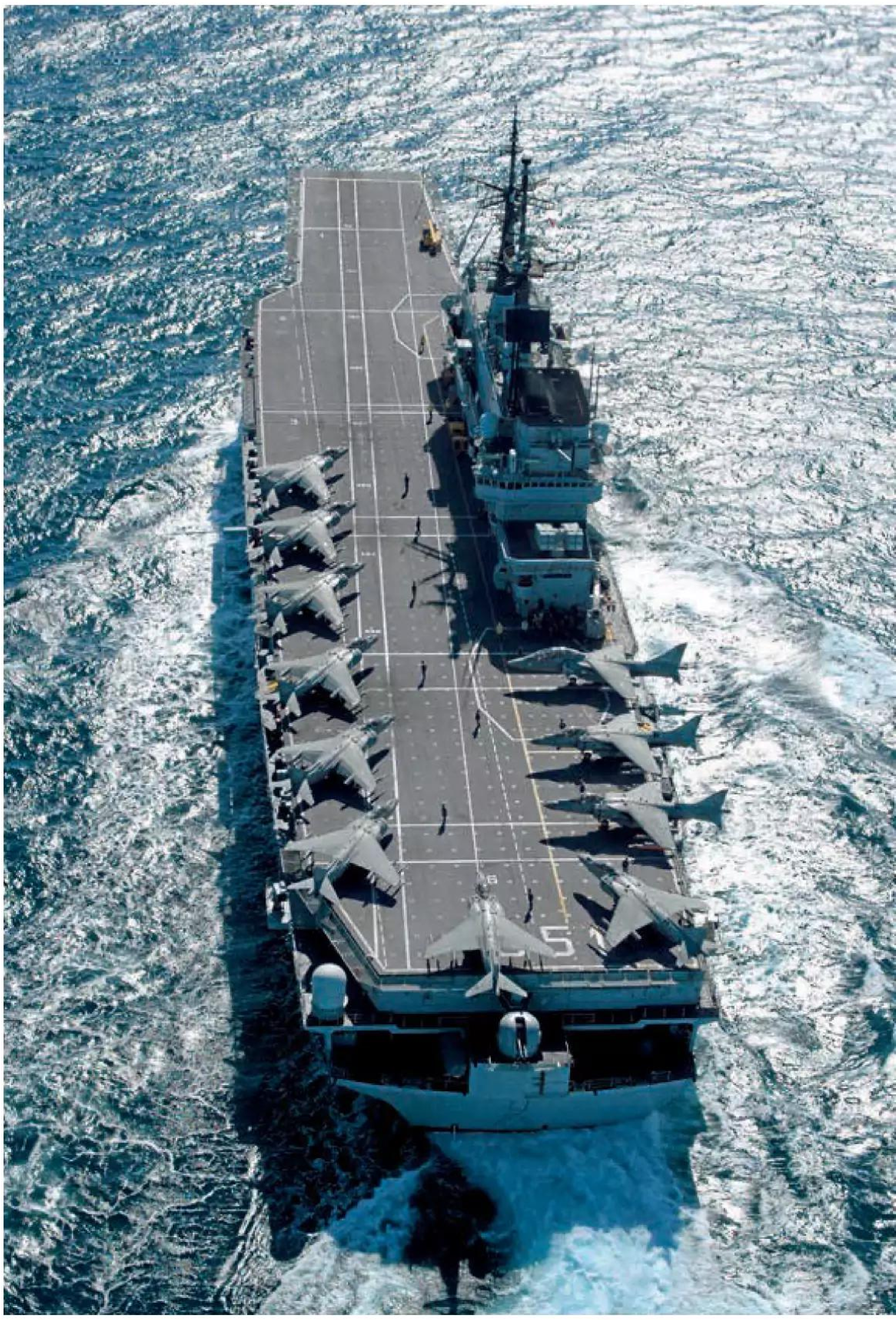
A McDonnell Douglas EAV-8B Harrier II Plus (Matador) of the Spanish Navy. **Keith Draycott**



A BAE Sea Harrier FRS.51 of 300 NAS of the Indian Navy. The white tiger is in its usual position on the nose, and the name Puma appears on the fin. **Keith Draycott**



A before and after photograph. A Hawker Siddeley AV-8A Harrier of the Thai Navy formates on a Hawker Siddeley AV-8A Matador of the Spanish Navy. The Thai Navy bought the AV-8As from the Spanish in 1992. **François Prins**



Nine McDonnell Douglas AV-8B Harrier II Plus and a TAV-8B two seat trainer line the deck of the Guiseppe Garibaldi. **Luigino Caliaro**

direct ferry flight from the UK, covering 4800 miles from Dunsfold to land at Goa, the home of 300 Naval Air Squadron (NAS) of the Indian Navy.

A further 10 FRS.51s were ordered in 1985, along with another two T.60s, the last of this order being delivered in 1991. Due to the high accident rate experienced in service, a further seven FRS.51s were ordered in 1991 and delivered during 1992. The INS *Vikrant* was retired from service and scrapped, being replaced by the INS *Viraat*, which was fitted with a ski-jump in 1991.

INS *Viraat* was formerly HMS *Hermes*, of Falklands War fame. Lastly, in 2002, another two T.60 aircraft were delivered, having been modified from two former RAF T.4s and designated as T.41s by BAE. Israeli Aircraft Industries then upgraded 15 of the Indian Navy's Sea Harriers. This included fitting the Elta EL/M-2032 radar and ability to carry the Rafael 'Derby' medium range air-to-air missile. INS *Viraat* was decommissioned in 2017 and the Indian Sea Harriers flew their final sortie in May 2022 before being dispersed to various museums. They have been replaced in service by MiG-29Ks, operating from INS *Vikramaditya*, formerly the Soviet Kiev-class carrier *Baku*, and the new INS *Vikrant* – which entered service in 2022.

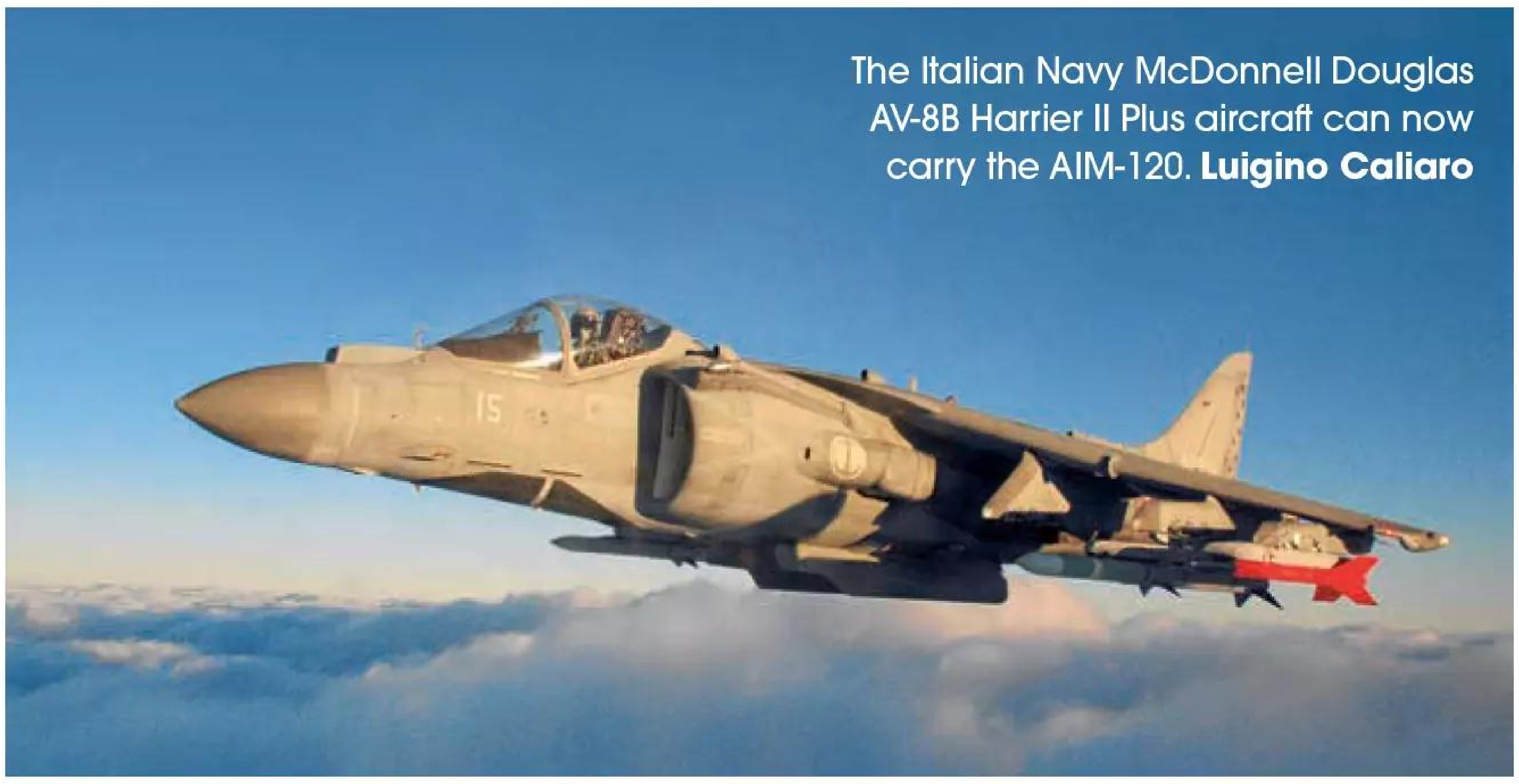
ITALIAN NAVY

In 1968, Hawker Siddeley demonstrated the Harrier to the Italian Navy on board the helicopter carrier Andrea Doria, piquing Italian interest in acquiring the aircraft. Strangely, an Italian law of 1937 prevented this acquisition, as fixed wing aircraft were

Four McDonnell Douglas AV-8B Harrier II Plus fighters of the Italian Navy over the aircraft carrier Guiseppe Garibaldi. **Luigino Caliaro**

Two McDonnell Douglas AV-8B Harrier II Plus of the Italian Navy on the break. **Luigino Caliaro**

Inside the cockpit of a McDonnell Douglas AV-8B Harrier II Plus of the Italian Navy. . **Luigino Caliaro**


The Italian Navy McDonnell Douglas AV-8B Harrier II Plus aircraft can now carry the AIM-120. **Luigino Caliaro**

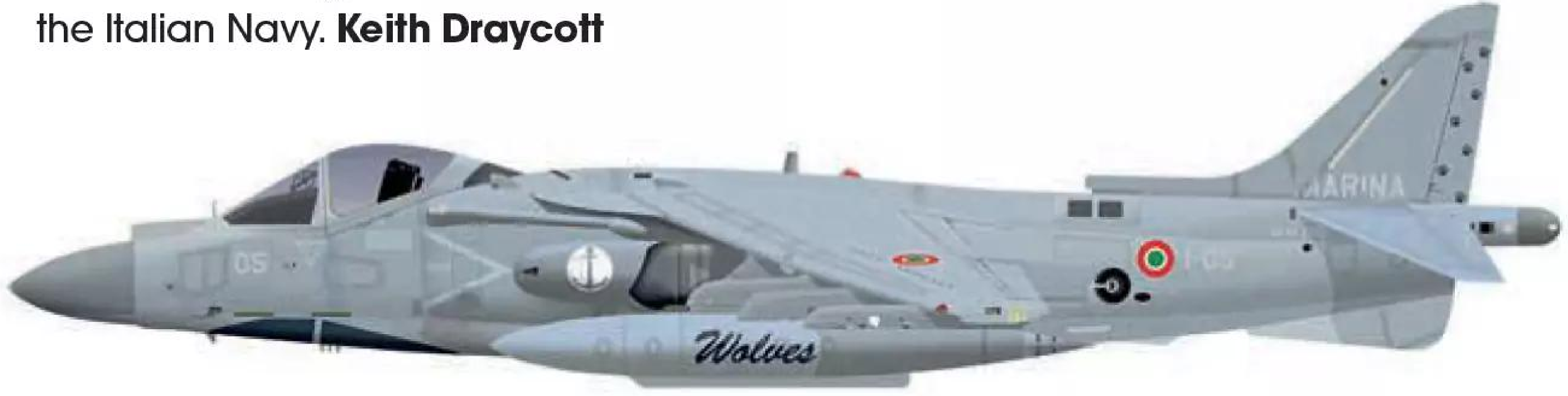
solely the responsibility of the Italian Air Force, the Navy were forbidden to operate anything except helicopters. It was not until this law was repealed in 1989 that the Navy was able to pursue its interest any further.

During the late 1980s, both the Sea Harrier and AV-8B were the subject of a prolonged evaluation by the service. In May 1989, this resulted in an initial order for two TAV-8Bs, but built to Harrier II Plus standards with the Pegasus 11-61 or F402-RR-408 engine of 23,800lb (10,795kg) thrust. These two aircraft were delivered to the Primo Gruppo Aereo Marina Militare at Grottaglie in August 1991, and were used for proving flights on various Italian ships, including the aircraft carrier *Guiseppe Garibaldi*. While these first trainer aircraft were being built in the US, a contract was negotiated for a further 16 AV-8B Harrier II Plus single seat radar equipped fighters. The first three of these were built in the US, the rest were assembled in Italy by Alenia Aeronautica from kits supplied by Boeing.

The first three single seaters were delivered in 1994 to MCAS Cherry Point, where Italian Navy pilots underwent conversion training. In January 1995, the Italian Navy Harriers conducted a three-month deployment to Somalia as part of a stabilisation force following the UN withdrawal from that country. During the mission, the Harriers flew reconnaissance and other sorties from the *Guiseppe Garibaldi* and maintained a 100% availability rate, an impressive reliability record. The *Guiseppe Garibaldi* was decommissioned in October 2024. At the time of writing, the Italian Navy was in the process of retiring its last remaining Harriers. However, it was reported in March 2025 that Indonesia had shown some interest in acquiring both the carrier and the remaining aircraft. ■

Words: Tim Callaway

McDonnell Douglas AV-8B Harrier II Plus of the Italian Navy. **Keith Draycott**



Last Harrier Down

The British Coalition Government's Strategic Defence and Security Review of October 2010 was to result in the retirement of the last RAF and Royal Navy Harriers. These aircraft had proved incredibly reliable and effective throughout their last operational deployment, six long years during the war in Afghanistan. In the light of this operational experience, Harriers had only just undergone an extensive upgrade programme, a programme which was ongoing right up to the point the announcement was made. The retirement was seen by many as woefully premature, leaving a gap in capability of more than eight years – up to the UK's F-35B fleet being declared combat-ready in January 2019. David Oliver has the full story of the last years of this great aircraft's service.

For nearly a decade following the end of the Cold War, the RAF Harrier's star was waning, but its career was to be revived as the result of events of September 11, 2001. On that day, a suicide attack by Al Qaeda terrorists on New York killed more than 3000 people and set in motion a war on the other side of the globe.

On October 7, 2001, US and British forces launched Operation Enduring Freedom with aerial bombing campaigns in Afghanistan targeting Taliban and Al Qaeda training camps, prior to a NATO-mandated invasion of Afghanistan by ground troops. After the fall of Kabul in November 2001, the number of British forces in Afghanistan increased dramatically, to support US-led Coalition fighting against a resurgent Taliban and other militant forces.

Herrick is the operational name under which all British operations in the war in Afghanistan have been conducted since 2002. It consists of the British contribution to the NATO-led International Security Assistance Force (ISAF) and support to the US-led Operation Enduring Freedom (OEF). Since NATO took command of ISAF in 2003, Operation Herrick increased in size and strength to match the growing geographical intervention in Afghanistan.

In response to a coalition request for the United Kingdom to provide a CAS capability to coalition forces operating in Southern Afghanistan, the UK MoD agreed to the deployment of six Royal Air Force Harrier GR.7 aircraft to Kandahar in September 2004. The aircraft were initially provided by No 3 Squadron flown by No 1 (F) Squadron crews and the deployment was planned to be for nine months. For the first time since its formation three years earlier Joint Force Harrier (JFH) was about to show its teeth.

Although the US Air Force elements operated from the vast former Soviet air base at Bagram, and NATO coalition air forces from Kabul, the closest airfield to the British area of operations in Helmand province was Kandahar Airport. Originally built in 1962 with US financial aid and technical assistance under the US International Development Programme, Kandahar Airport was intended to become the largest international airport in Central Asia. However, it was severely damaged by Soviet air attacks between 1979-89, and again by US air raids during Operation Enduring Freedom when the airport was the site of what was thought to be the Taliban's 'last stand'.

By the time it was decided to deploy British combat aircraft to Afghanistan, Kandahar Airport's 10,000ft runway was breaking up and in serious need of repair. The only type that could use it safely in the hot summer temperatures with a full weapons payload was the RAF Harrier with its short field take-off and landing capability. Early operations involved nothing more than scaring away the enemy with a "show of force" – flying at 100ft at full throttle firing off chaff and flares.

However, the tempo rose when British troops went on the offensive in Helmand province in early 2006. Over 500, 540lb and 1000lb 'iron' bombs were dropped by

No 1 (F) Sqn Harrier GR.7 on patrol over the Afghan mountains in 2006 armed with CVR-7 rocket pods and 540lb iron bombs. **1 Sqn archives**

No IV (AC) Squadron between May and October 2006 during its second four-and-a-half-month deployment in the country. The Harriers' missions were CAS, tactical reconnaissance, and low and high tempo warfighting, often flying in 'packages' with USAF A-10s and B-52s. Up to August 2006, mainly day missions had been flown, but 24-hour availability became necessary as the ground fighting intensified, resulting in an increase in squadron personnel deployed to Kandahar. At the same time the number of Harriers was increased to seven as operational flying hours doubled to some 480 a month. As well as 16 pilots, around 125 engineers and technicians and all the squadron's operational personnel were in Afghanistan. Maintenance crews initially undertook 12-hour shifts day and night for 10 days at a time.

When 800 Naval Air Squadron took over September 2006 under the command of its charismatic CO, Commander Adrian Orchard, the Royal Navy triple trade maintainers introduced their own flexi-maintenance package which reduced the down time of the Harriers in their charge. Cdr Orchard likened Operation Herrick to a Korea-type war and said that it was: "the most mentally challenging flying I have done."

In order to self-designate targets, the Harriers initially used the BAE systems TIALD pod equipped with a high resolution forward-looking infra-red (FLIR) and a laser designator that automatically tracks the target once it has locked on. Operation Herrick had highlighted the shortfalls of the TIALD pod, especially in the ➤

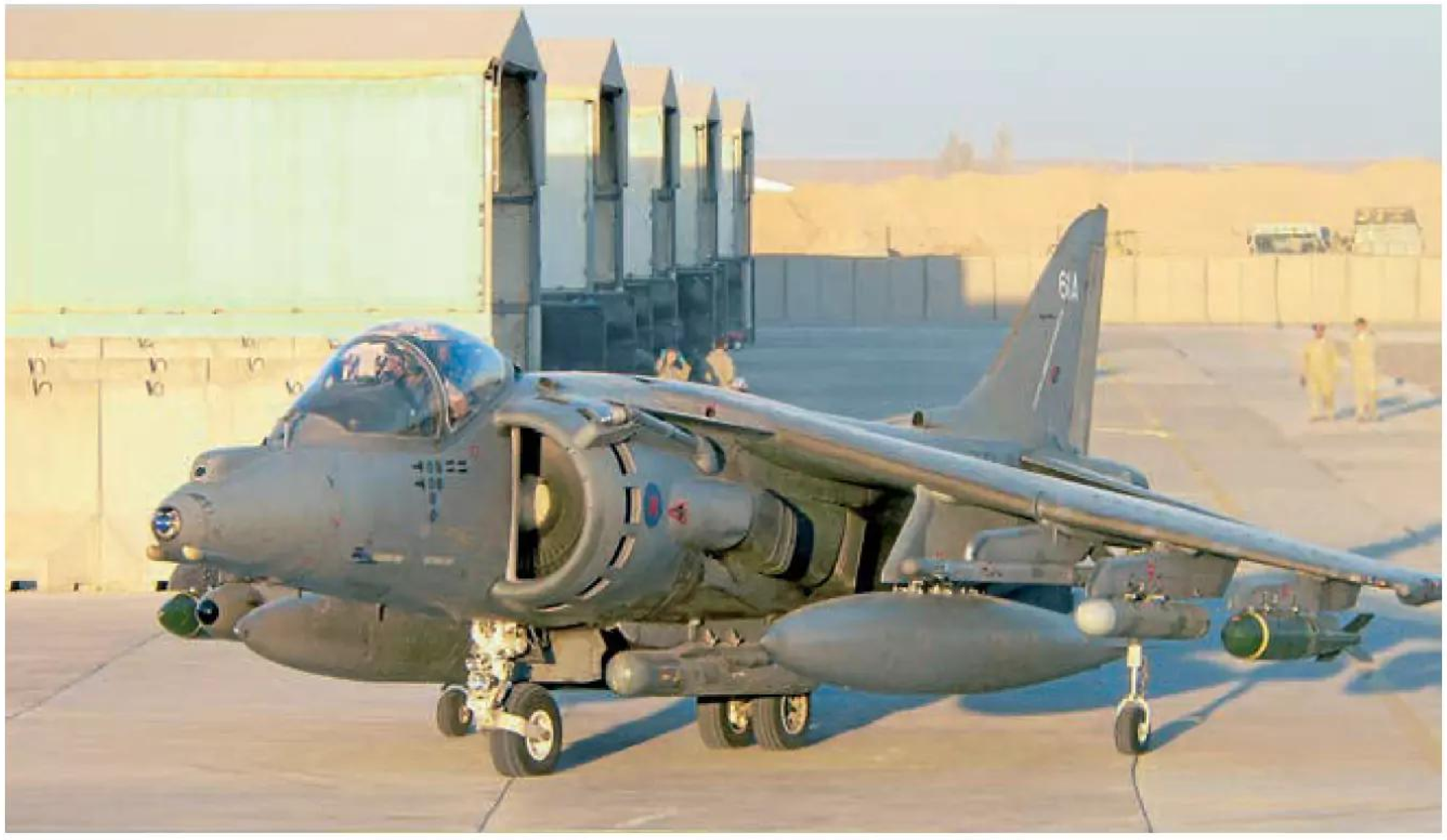
Firing flares from a No 1 (F) Sqn Harrier GR.7 on a medium altitude patrol over Afghanistan. **1 Sqn archives**

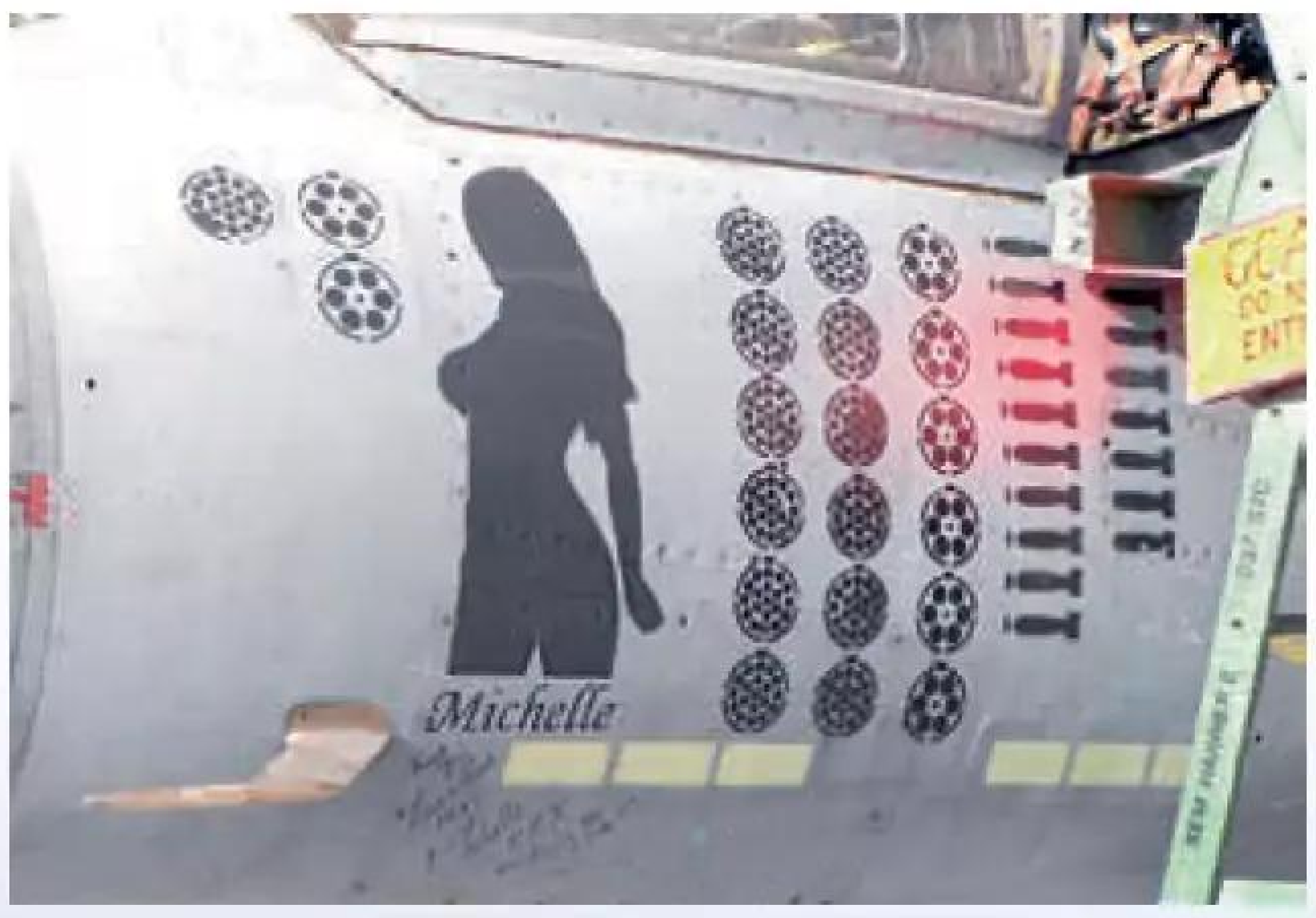
An 800 NAS GR.7 in its hide at Kandahar carrying Paveway IIs and a TIALD pod. **David Oliver**

Fully armed No 1 (F) Sqn Harrier GR.7 ZD433/45A taxies at Kandahar Airfield in early 2006. **David Oliver** urban CAS role. As a result, an Urgent Operational Requirement (UOR) was issued in late 2006 for a new pod, resulting in the first AN/MQ-33 Sniper Advanced Targeting Pod being test-flown on a Harrier GR.9 on December 1, 2006.

A contract was given to Lockheed Martin to deliver the pod in February 2007, and deliveries were completed only four months later. Sniper allowed the Harrier pilot to detect and identify weapons caches – and even individuals carrying arms – while the aircraft is far enough away for it not to be heard. In early May 2007 No IV (AC) Squadron became the first RAF unit to train with it, taking it with them when the squadron deployed to Afghanistan again in mid-June 2007. When linked with the handheld L3 Remote Operations Video Enhanced Receiver (Rover) terminal, forward air controllers on the ground could view real time imagery downloaded from the Harrier's targeting pod.

The Harriers were armed with a mix and weapons and recce/targeting pods also used Paveway IIs and Enhanced Paveway (EPW) II and III plus laser-guided munitions, 'iron' bombs, AGM-65G-2 Maverick day/night airto-surface missiles, CRV-7 unguided rockets and AIM-9L sidewinders, for self-defence. What many pilots regretted was summed up by Royal Marine Major Dave Kelly, a former Sea Harrier pilot serving with No 1 (F) Squadron which was deployed to Afghanistan from December 2005 to May 2006. Simply put it was 'No guns! – Pity.' Although the twin 25mm Aden gun installation problems had been overcome, they were not part of the Harrier's Herrick weapon fit.


800 NAS GR.7 ZG471/61A wearing mission symbols breaks cover at Kandahar to begin a patrol. **David Oliver**

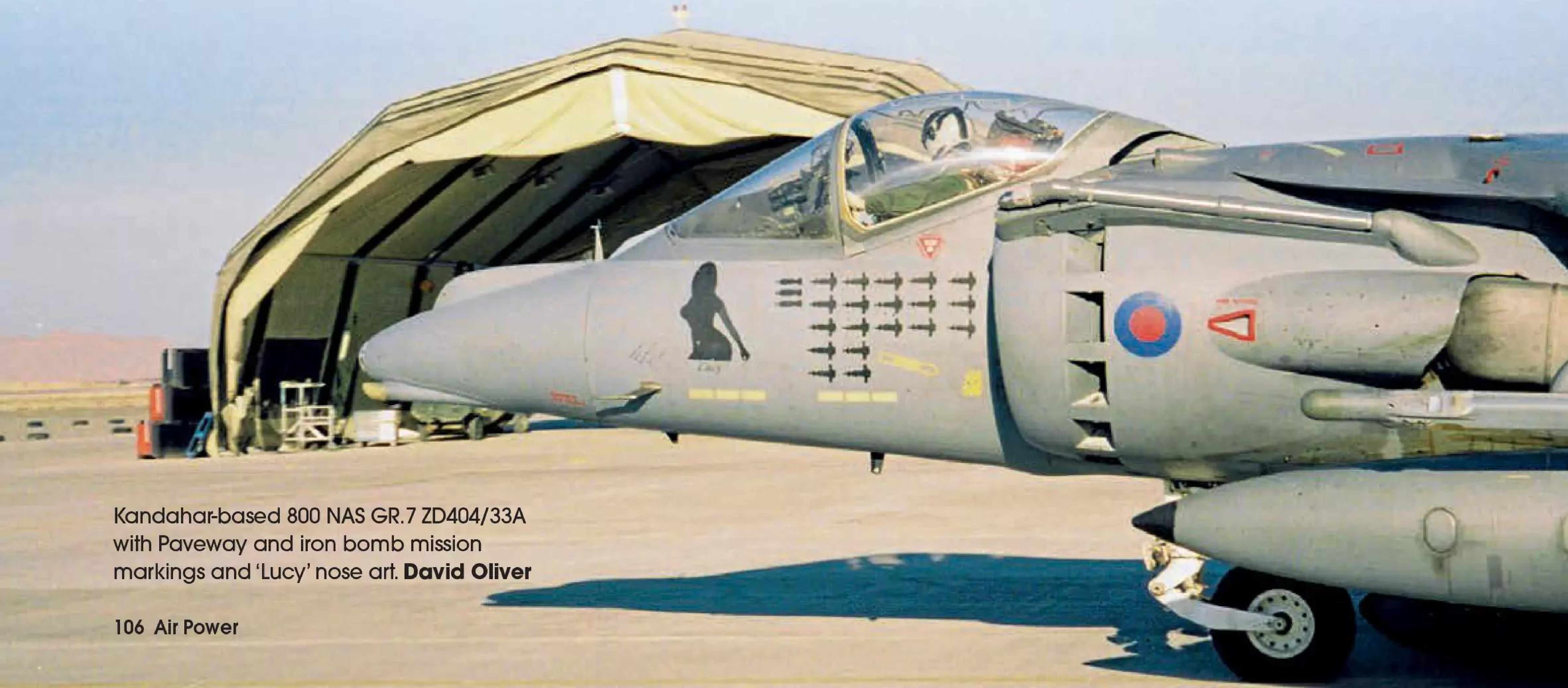

CVR-7 and iron bomb mission marking and 'Michelle' nose art adorning 800 NAS GR.7 ZD437/49A. **David Oliver**

However, the Harrier GR.9 was the lead airframe for the Global Positioning System Aided Inertial Navigation System (GAINS)/ laser-guided Paveway IV and for anti-armour and high-value battlefield targets, the Brimstone missile was later adopted. In addition to CAS, the Harriers undertook nontraditional intelligence surveillance reconnaissance OSR) in Afghanistan to determine enemy activity and provide that information to troops on the ground. Up to 11 Harriers were deployed at Kandahar at any one time, and the force begun to transition from GR.7As to upgraded GR.9As towards the end of 2007.

With upgrades to the RAF's Harriers to GR.7A and eventually to GR.9/9A standard in the pipeline, the MoD had decided in 2002 to retire prematurely the less capable Sea Harrier FA.2 in 2002. By March 31, 2006, the last Sea Harriers had flown from Yeovilton to RAF Shawbury for disposal, their Royal Navy Squadrons, 800, 801 and 899 having disbanded at RNAS Yeovilton.

In early 2008, the Harrier fleet began a midlife upgrade that saw the GR.7s modified as GR.7As, GR.9s or GR.9As. The GR.7A had a Rolls-Royce Pegasus Mk.107 power plant in place of the GR.7's Mk.105, with an additional 3000lb (13.4kN) of thrust. A total of 40 such modifications were made. In addition, around 70 GR.7s and GR.7As benefited from an avionics and weapons upgrade to become GR.9s which became the new baseline standard for the Harrier fleet. GR.7As which had gone through both the avionics and engine upgrades were designated GR.9As.

JFH was also responsible for providing combat aircraft for the Royal Navy's aircraft carriers and along with the Operation Herrick commitment, this meant that JFH was among the RAF's most frequently deployed assets. In March 2007 the Naval Strike Wing (NSW) was formed comprising of elements of 800 and 801 Naval Air Squadrons (NAS) to form what was the Fleet Air Arm's only fixed wing strike force. The


Kandahar-based 800 NAS GR.7 ZD404/33A with Paveway and iron bomb mission markings and 'Lucy' nose art. **David Oliver**

OP HERRICK
DEC 05 – MAY 06
OPERATION HERRICK
07 APR 05 – 31 JUL 05
IN FUTURUM VIDERE

Blast pan artwork from the first two Harrier deployments of Nos IV (AC) and 1 (F) Squadrons to Afghanistan. **David Oliver**

The head-up display in a No 1 (F) Sqn Harrier GR.7 on a night patrol over Afghanistan. **1 Sqn archives**

NSW was one of three squadrons, the others being Nos 1 (F) and IV (AC) Squadrons RAF that make up JFH. 801 NAS had been recommissioned in October 2006 adding its distinctive black and white chequered tail to the existing 800 NAS Squadron Harriers GR.7s. 800 NAS had reformed on March 31, 2006 and was allocated 13 Harriers from RAF Cottesmore as part of JFH.

JFH was now operating from just RAF Cottesmore and RAF Wittering. Under JFH, Cottesmore was the home of 800 NAS followed by 801 NAS in October 2006 with 1 (F) and IV (AC) Squadrons, each operating nine Harrier GR.7/7A or GR.9/9As. RAF Wittering was responsible for the training of all RAF and Fleet Air Arm Harrier pilots and was operating the two-seat Harrier T.10 of which 11 were upgraded to T.12 standard. In March 2010, 800 and 801 NAS were merged to form a single squadron as part of the newly established Joint Strike Wing OSW) that comprised No 1 (F) Squadron and 800 NAS.

However, by this time the MoD had decided to replace the Harriers in Afghanistan with Tornado GR.4 aircraft and No 1 (F) Squadron brought its eight Harrier GR.9As back from Kandahar to RAF Cottesmore for the last time in July 2010. The Harriers had completed an uninterrupted five-year deployment in theatre, during the longest period of high-tempo sustained operations since the Second World War. During this time the Harrier proved itself extremely reliable and effective, with JFH accomplishing 8557 operational sorties, 22,772 flying hours and a remarkable technical serviceability rate of more than 99%. None were lost to enemy fire or accident, and only one was severely damaged enough to be air freighted back to the UK after being hit on the ground at Kandahar during a rocket attack in 2005.

The end of JFH's Herrick commitment coincided with the last phase of the GR.9 upgrade programme which included revised software to allow training mission to be flown without the need to carry a captive training round since the aircraft's own software was now able to emulate the weapon system and enabled full control over the Digital Joint Reconnaissance Pod. Other upgrades included the Harrier Advanced Mission Planning Aid (HAMPA) and the integration of Saturn secure communications.

The final phase of the programme was to provide network enabled capability through Link 16 and Variable Message Format (VMF) datalink with the integration of the Tactical Information Exchange Capability (TIEC) to enable Harrier GR.9 pilots to join the digital battlefield. Design authority clearance for these upgrades was planned for mid-2011 and delivery of an operational capability by the end of 2012. All of the Harrier GR.9/9A upgrades had been introduced by the Harrier flight of No 41 (R) Squadron based at RAF Coningsby, the RAF's Fast Jet and Weapons Operational Evaluation Unit (FJWOEU) formed on April 1, 2004.

Lieutenant Simon Rawlins RN, a veteran of five Afghan tours and 193 operational sorties, was responsible for the introduction of the Paveway IV bomb into operational use while work continued to integrate Spear, a development of the dual-Brimstone missile that was part of the next generation of airlaunched smart weapons destined for the Harrier in 2012.

2010 was set to be a busy year for postAfghanistan JHC with No IV (AC) Harriers taking part in Exercise Red Flag in Nevada and six No 1 (F) Squadron aircraft embarking on HMS *Ark Royal* for the first time for some considerable period, and participating in Exercise Auriga, a two month-long carrier deployment in waters off the eastern seaboard of the United States and Canada. However, it was also the beginning of the end for Joint Force Harrier. Only six weeks after returning from the United States, No IV (AC) Squadron was disbanded on March 31, although the historic number plate was passed on the Harrier Operational Training Unit (OTU), No 20 (R) Squadron at RAF Wittering, which became IV (R) Squadron.

During Exercise Auriga, the Harriers flew 308 sorties, 89% of those planned, totalling 440 hours 15 minutes, dropped 244 practice bombs, 14 high-explosive and ➤

A JFH GR.9 recovers to HMS *Ark Royal* during Exercise Auriga in US waters in June 2010. **Crown Copyright**

The last Harrier to launch from HMS *Ark Royal* on November 24, 2010, was flown by Lt Cdr James 'Blackers' Blackmore. **Crown Copyright**

Lt Chris 'Casper' Roy's comment on his last landing on *Ark Royal* in his 800 NAS Harrier on November 19. **David Oliver**

11 free-fall high-explosive substitute 1000lb bombs. Ironically, in view of later events, six pilots were deck-qualified for the first time and another 10 requalified.

In September 800 NAS headed for Cyprus to take part in the four-week bi-annual Exercise Harding Flame to gain day and night CAS training with Army units, and Joint Tactical Air Controllers (JTACs) who played such a vital part in Harrier operations in Afghanistan. As the exercise came to an end the long-awaited outcome of the UK's new Coalition government's Strategic Defence and Security Review (SDSR) was about to be revealed in October 2010.

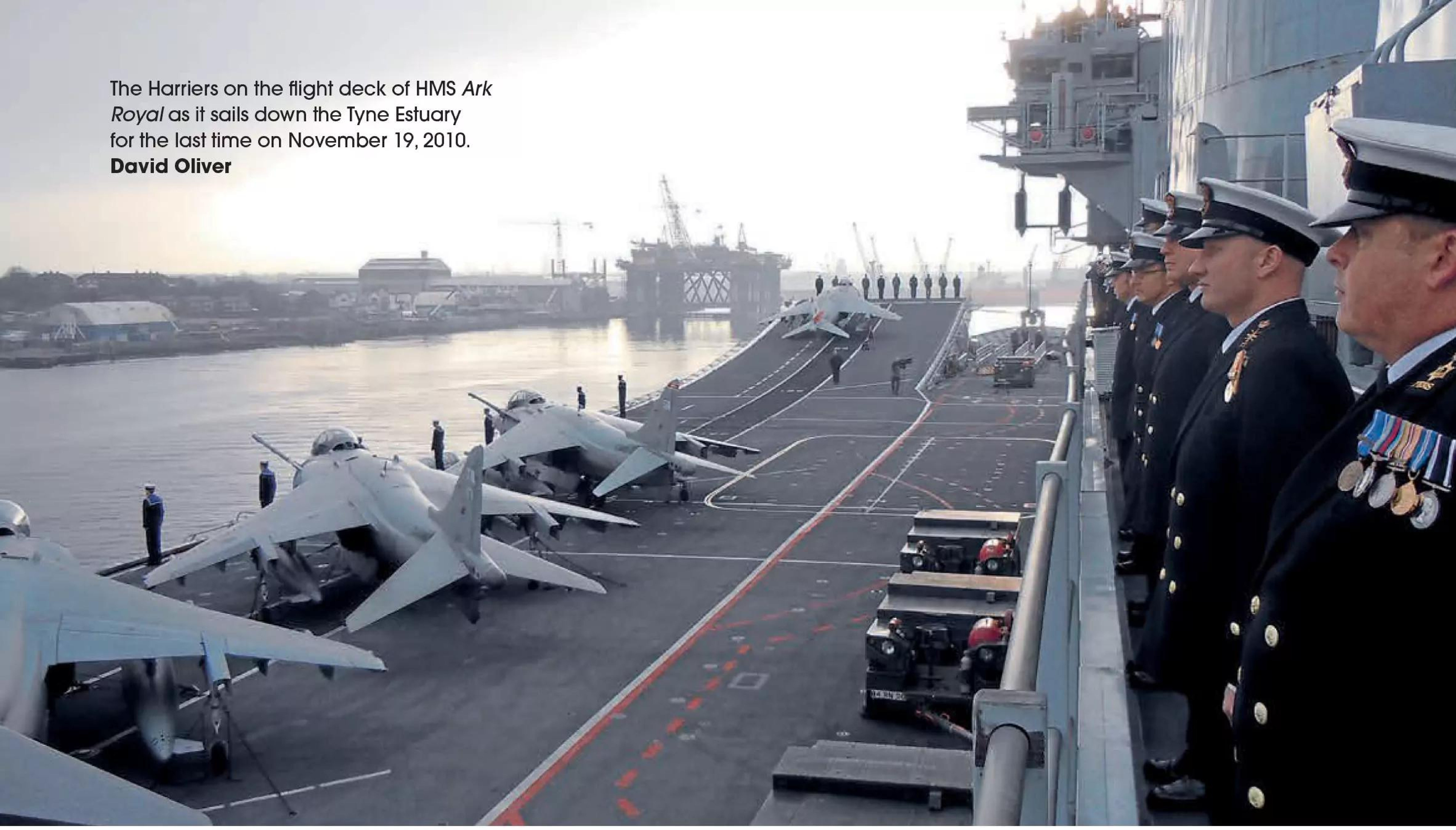
What many defence pundits had predicted was that if the two new Queen Elizabeth class aircraft carriers were cancelled, so would the STOVL version of the F-35 Joint Combat Aircraft, and JFH's day would be numbered. If the carriers and the F-35s were not cancelled, JFH continue to maintain the UK's carrier strike capability for at least another decade. In the event, both JFH and the carrier *Ark Royal* were to be sacrificed. With all Harrier development suspended overnight, the first to go was the Harrier Flight of No 41 (R) Squadron which departed Coningsby on November 4, for Cottesmore and retirement.

At 11.55 hours on November 19, 2010, off the coast of Newcastle, a Joint Force Harrier GR.9 landed on the flight deck of the UK's Fleet Flagship and Strike carrier, HMS *Ark Royal*, for the last time. As announced in the UK SDSR, Joint Force Harrier's fleet of aircraft was to be retired on December 14, 2010, and HMS *Ark Royal* decommissioned in April 2011.

The carrier was preparing for five-weeks of night qualification flying with the Joint Force Harriers when the news of its imminent demise was broken by the Prime Minister. Captain Jerry Kyd, who assumed command of *Ark Royal* in September 2010, had to confess that the decision came as a shock, while the ship's Executive Officer, Cdr Rob Bellfield said: "We had one week feeling sorry for ourselves", before concentrating on planning for the ship's last few weeks at sea.

After being disarmed at Glen Mallen Jetty in Loch Long, which services the NATO armament depot built into the hillside of Glen Douglas, Ark Royal made her way to the Clyde Estuary for the last time on November 17. Following a 750-mile circumnavigation of Scotland, the next port of call was to be her birthplace on the

The last four pilots to land on *Ark Royal*, left to right, W/C Dave Haines, Sqn Ldr Chris Cartmell, Lt Chris Roy, Flt Lt Richard Heap and Lt Adam Hogg, the landing signals officer on the carrier. **David Oliver**



The Harriers on the flight deck of HMS *Ark Royal* as it sails down the Tyne Estuary for the last time on November 19, 2010. **David Oliver**

River Tyne. On November 18, four Joint Force Harriers were scheduled to land on to join the carrier's 814 NAS Merlin HM.1 helicopter, but the weather conspired against them. The UK Flag Ship was buffeted by gale force winds and Sea State 6 as it rounded the northeast tip of Scotland and made a high-speed dash for the relative shelter of the Moray Firth, but the weather remained out of limits for the Harriers.

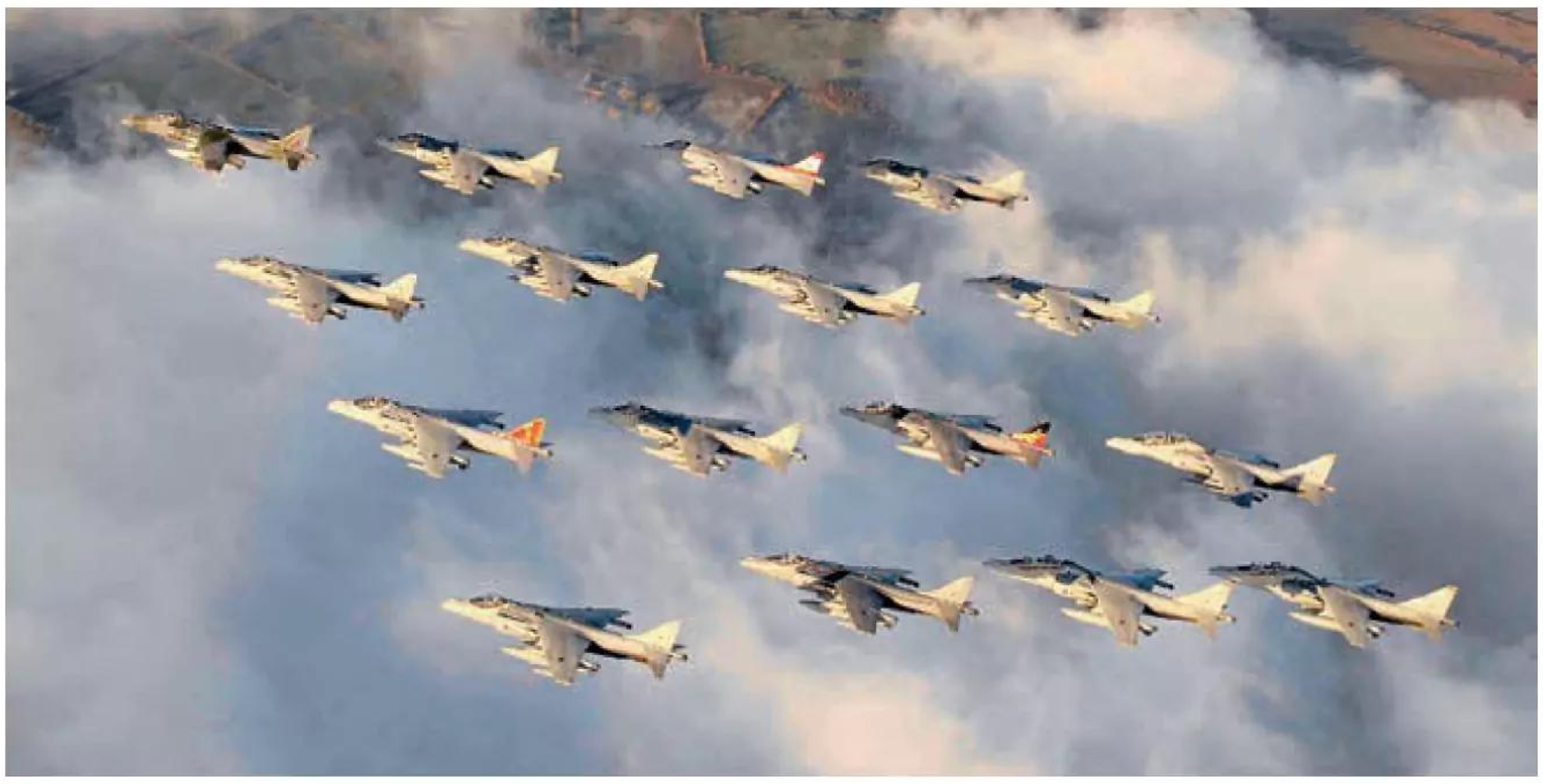
The following day conditions improved and despite RAF Cottesmore being Condition Red due to early morning fog, the first pair of Harriers, from Nos 1(F) and IV (R) Squadrons, broke through the overcast to land on *Ark Royal* within a minute of each other. The second pair landed on 10 minutes later, the last being an 800 NAS jet. The pilots on this historic last sortie were Wing Commander Dave Haines, OC No 1 (F) Squadron, Squadron Leader Chris Cartwell, Lieutenant Chris Roy RN, and the last man down, Flight Lieutenant Richard Heap.

A few minutes later, three helicopters recovered to *Ark Royal* for the last time, the Merlin that acted as a ship guard, and a pair of 845 NAS Sea King HC.4s from Yeovilton. A few hours later the carrier docked at Newcastle for three days when thousands of local people had the opportunity of boarding the ship and getting a close look at the embarked Harriers for the last time. On a cold and wet morning of November 24, HMS *Ark Royal* headed out into the North Sea and the four Harriers made their last departure from a Royal Navy carrier. The pilots, Royal Marines Captain Mike Carty, Lieutenant Matt Fooks-Bale RN, Flight Lieutenant Emily Rickards and Lieutenant Commander James 'Blackers' Blackmore were soon lost to view in the murk as they set course for Cottesmore thus ending HMS *Ark Royal's* 25-year career of embarking fixed-wing aircraft.

The weather was not much better on the day of the Harrier's last 16-ship flypast from Cottesmore on December 15. After a delayed departure, the Harriers finally took off and joined formation before heading for RAF stations Wyton, Wittering, Waddington and Scampton, and RAF College Cranwell and Lincoln Cathedral. Sadly, due to overcast skies, few people on the ground witnessed the flypast which landed back at Cottesmore in worsening conditions. It was left to the Joint Force Harrier commander, Group Captain Gary Waterfall, to take a final bow in his GR.3-style camouflaged GR.9A before making a vertical landing prior to shut down.

As a postscript, only five days after HMS *Ark Royal* was decommissioned on March 12, 2011, the UK launched Operation Ellamy as part of an international coalition to enforce a Libyan no-fly zone in accordance with a United Nations Security Council Resolution.

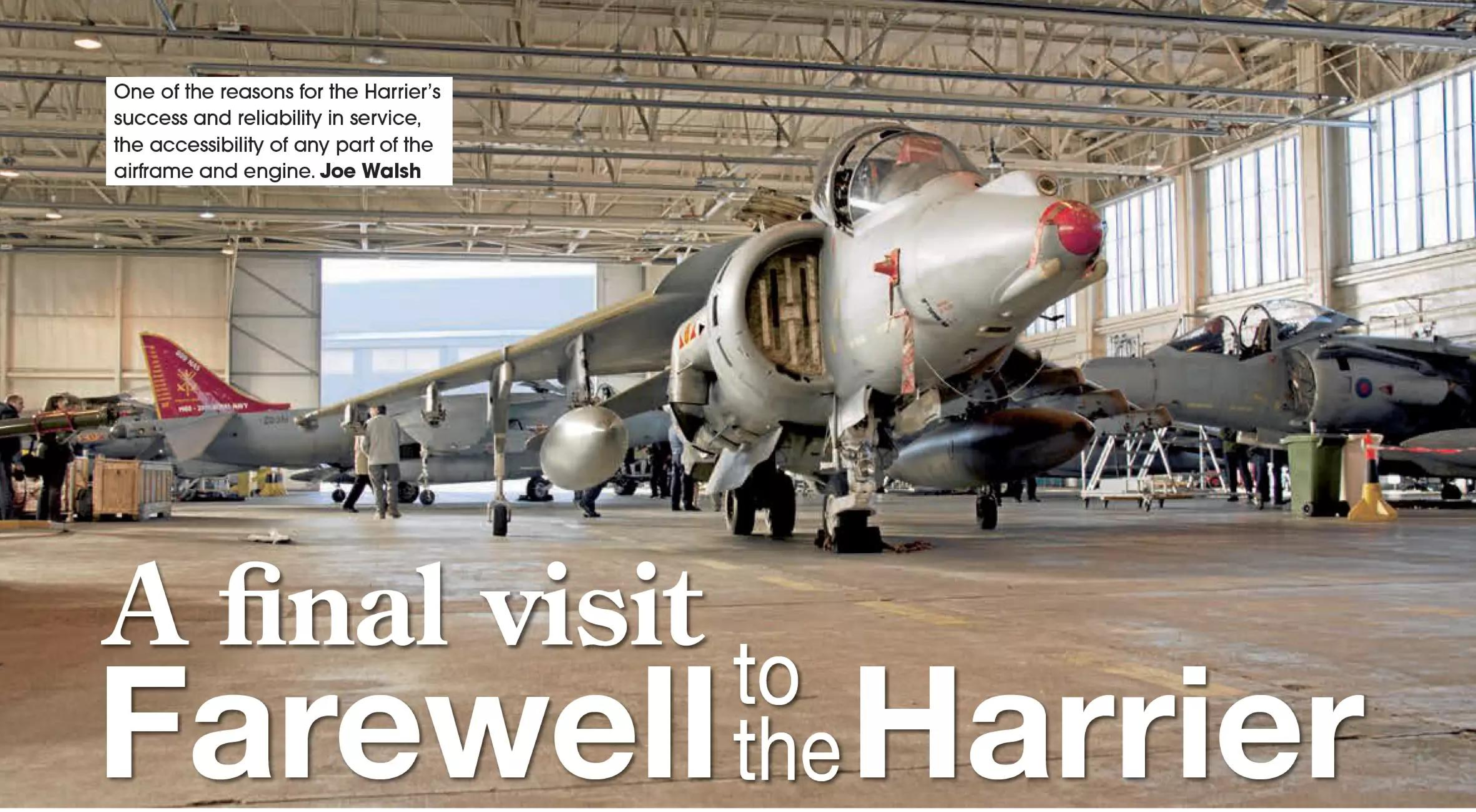
On March 19, RAF Tornado GR.4s flew from RAF Marham on a bombing mission to Libya to begin a long NATO-led campaign against Col Gaddafi's armed forces. It was the sort of operation that Joint Harrier Force had been designed for. To add insult to injury, on May 31, the United States Marine Corps announced that it had returned a squadron of AV-8B Harrier II combat aircraft to Kandahar Airfield in Helmand province to assume full responsibility for providing support for Afghan and ISAF operations throughout southern Afghanistan, exactly two years after Joint Harrier Force was withdrawn from the theatre. ■



Joint Force Harrier's last 16-jet flypast over a murky East Anglia on December 14, 2010, was led by JFH Commander Group Captain Gary Waterfall in a GR.3 camouflaged GR.9A ZG506. **Crown Copyright**

IRAQI FREEDOM

BAE Harrier II GR.7 ZD408/37 of No. 20(R) Squadron ✦
Ahmed Al Jaber Air Base, Kuwait ✦ 2003



One of the reasons for the Harrier's success and reliability in service, the accessibility of any part of the airframe and engine. **Joe Walsh**

A final visit

Farewell to the Harrier

On December 9, 2010, a group of journalists and historians were allowed to make a final visit to RAF Cottesmore and Wittering to record the final days of the Harrier in RAF service. There was to be a final flypast on December 15, but the group on that day knew they were witnessing the end of operational flying by the type. Joe Walsh was there to record the events.

The scene inside the 800 Naval Air Squadron (NAS) hangar at RAF Cottesmore. **Joe Walsh**

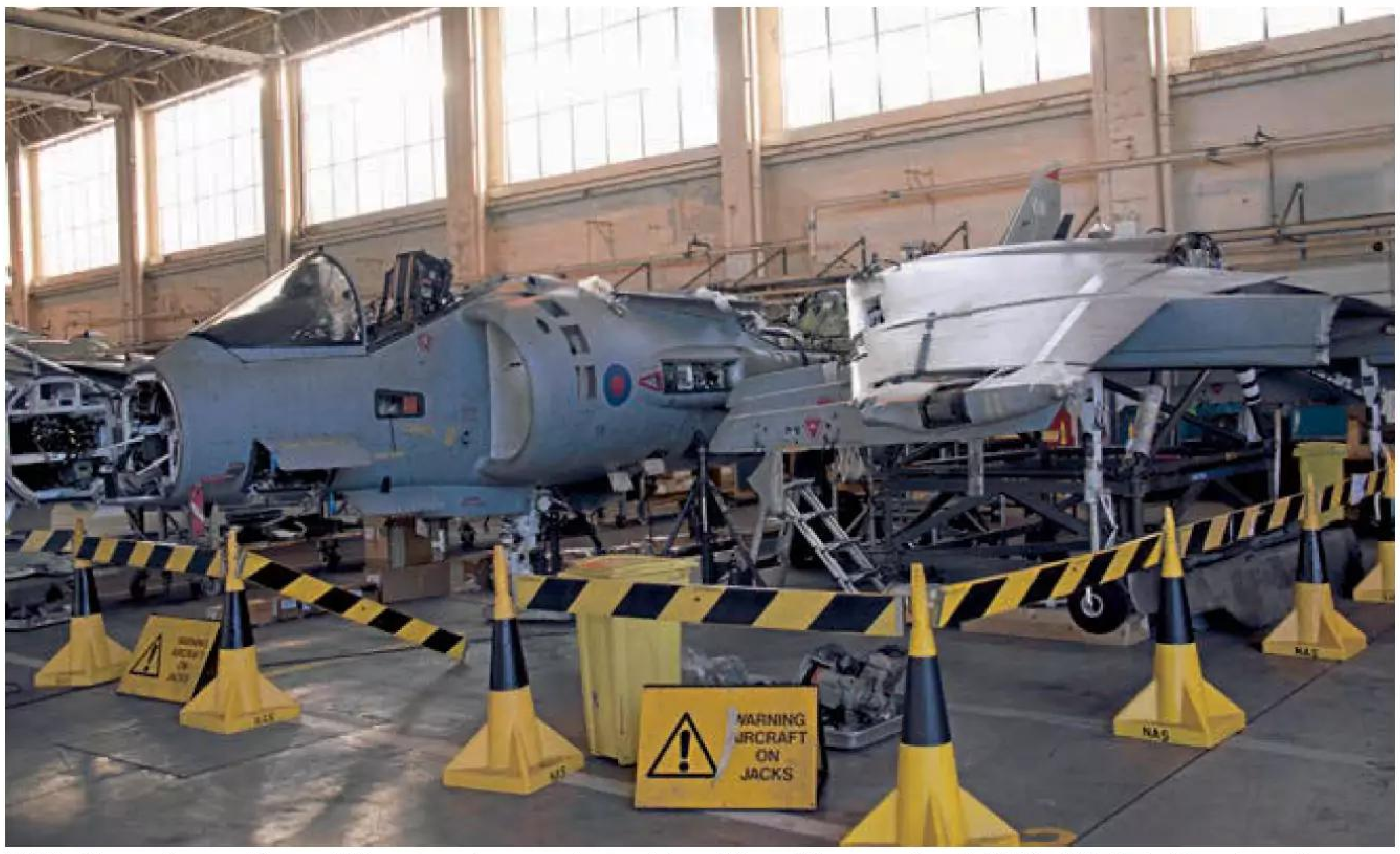
December 2010 in the UK was memorable for two things – a severe bout of winter weather and the unexpected end of all UK Harrier operations. Both were a massive surprise and the former was affecting the limited opportunities for the enthusiast to get some last photos of this iconic aircraft as both Harrier bases – Cottesmore and Wittering – were inactive due to freezing fog and levels of snow more commonly seen in Siberia!

There was a sense that the government's decision to retire the Harrier with some haste had really affected the morale of the proud members of Joint Force Harrier in a negative manner and it appeared that a final event for pictures would not be forthcoming from either of the two stations, with all requests for tours and on-base access denied.

Then, at the very end of November it appeared that, for a very small group of us, a visit to Cottesmore at least would be possible. An agreement was reached where invited photographers would be allowed on the base for a reasonable donation to charity which would be split between Combat Stress (Cottesmore) and the Battle of Britain Ops Room restoration project at RAF Northolt.

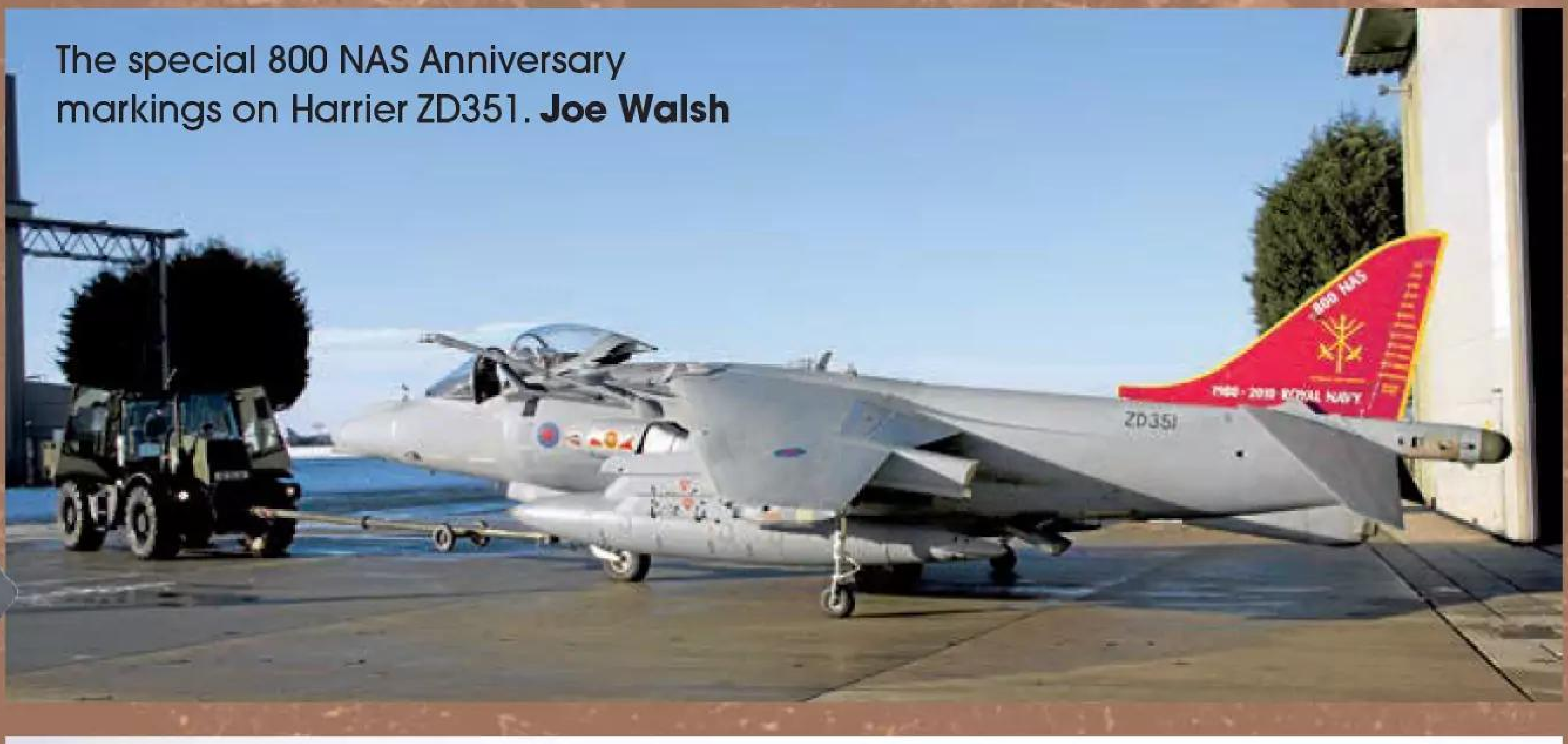
After two false starts due to the aforementioned weather, a decision was made late on December 8, that a do-or-die visit would be made the next day – the forecast weather at last being favourable enough to allow some flying at Cottesmore. As we travelled north from London, those travelling in the opposite direction called with news that the forecast, typically, hadn't quite got it right and the runway remained firmly closed due to ice. This also put paid to any idea of at least practicing some of the planned 16-ship flypast scheduled for the final day of operations.

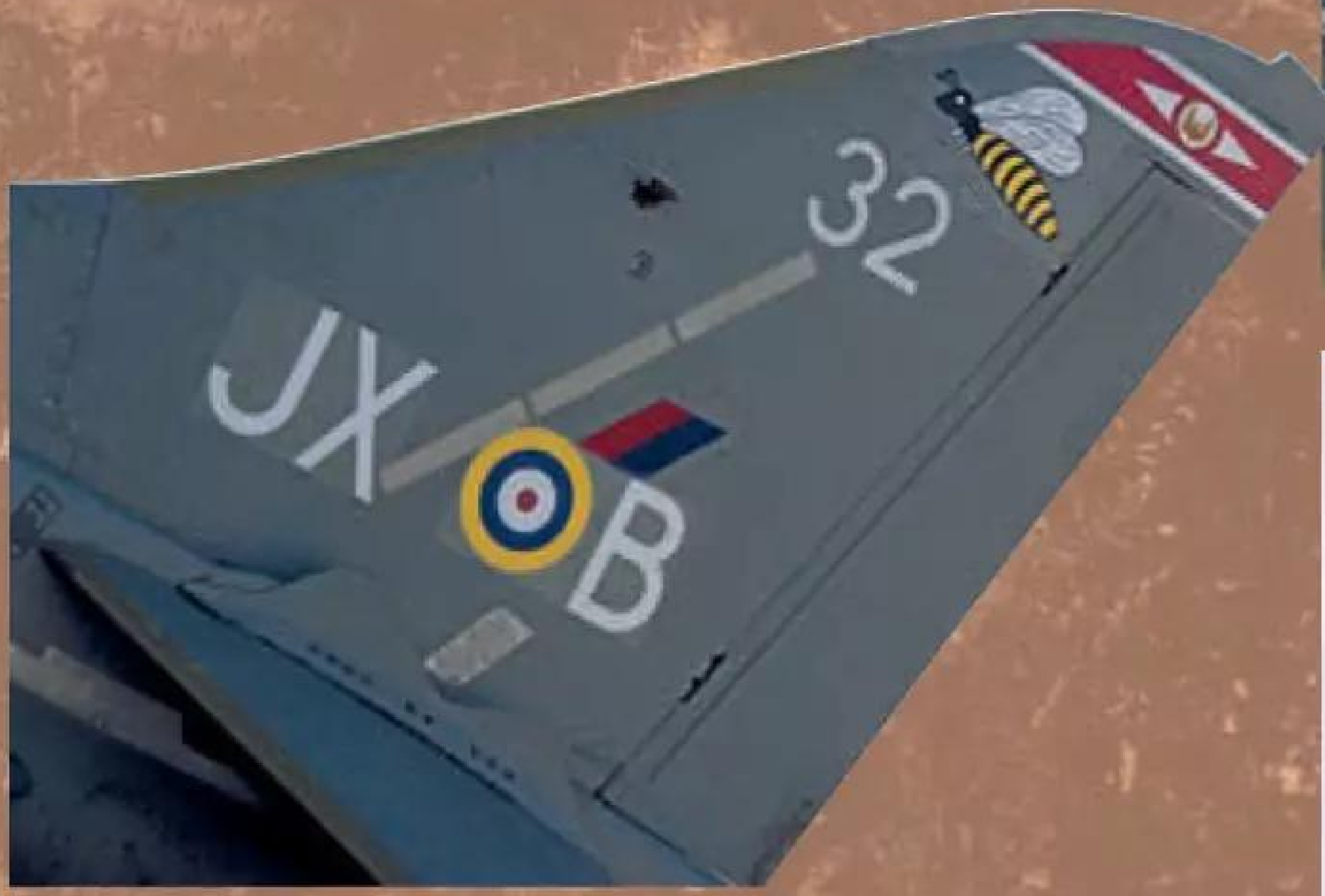
Our hosts in air traffic at the station though, Squadron Leader Ruth Davies and Flight Lieutenant Kate Reid, persuaded the last Naval Air Squadron, 800, to allow us a visit with the idea that we could then use that as leverage to do the same with 1 Squadron.



With the wing off and the engine out and looking like a giant Airfix kit. this Harrier shows how easy it was to work on the airframe. **Joe Walsh**

> “MANY OF THE HARRIERS HERE HAD MULTIPLE MISSION MARKINGS ON THE NOSE, A SIGN OF THE AIRCRAFT’S TIME IN AFGHANISTAN BEFORE THE TORNADOS REPLACED THEM IN 2009”


The special 800 NAS Anniversary markings on Harrier ZD351. **Joe Walsh**



Also on the Cottesmore flight line was ZD403 of 1 Squadron, carrying Battle of Britain period markings on the fin. **Joe Walsh**

BASE AEREA MILITAR MALVINAS
At RAF Wittering, the 1 Squadron hangar included reminders of former glories for the Harrier, including this sign from Port Stanley. **Joe Walsh**

Harrier T.10 ZH659 makes the last operational landing of a Harrier at Wittering, ‘Home of the Harrier’ no more. **Joe Walsh**

Once with the Navy boys, we were given free rein with our cameras to capture various Harriers in many states – some of them decidedly second-hand like full-scale Airfix models.

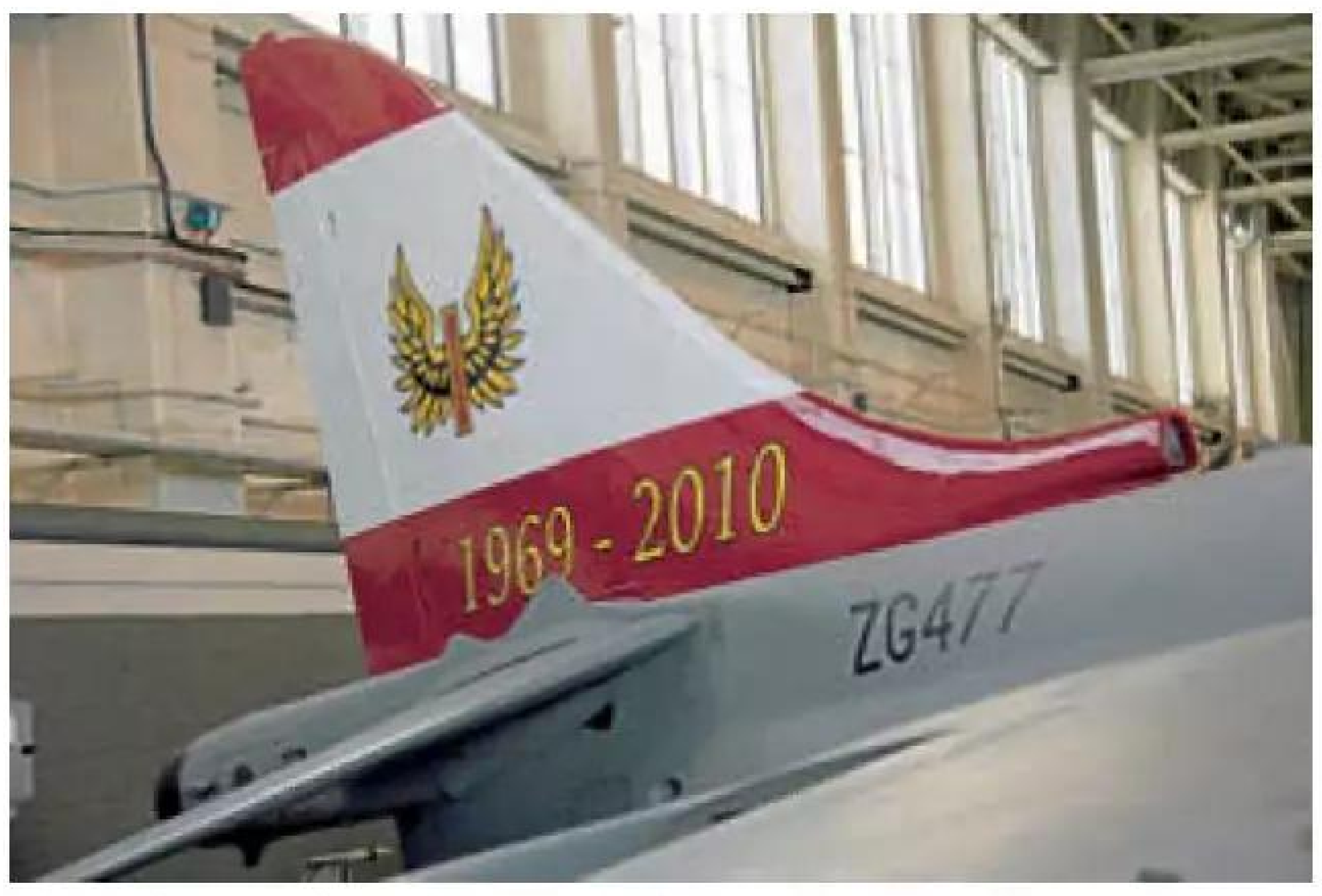
Outside, it was a glorious winter’s day, and the group followed the 800 NAS red-tailed ‘special’, ZD351, onto the flightline where a dozen-or-so aircraft were being tended to despite the lack of flying. Thick, black ice made the conditions underfoot very treacherous indeed and great care had to be taken not to perform some low-level acrobatics with expensive cameras and lenses. On the line were a couple more one-off schemes, notably ZD403/32 with Battle of Britain-era code ‘JY-B’ and wasp commemorating the Hurricane I flown by Pilot Officer AV ‘Taffy’ Clowes. Also present was one of the Harriers flown by 41 (R) Squadron at RAF Coningsby which were flown into Cottesmore within days of the withdrawal announcement.

One of the already retired ‘gate guardian’ airframes at Cottesmore, 800 NAS’s former mount, the now rare Sea Harrier FA.2. **Joe Walsh**

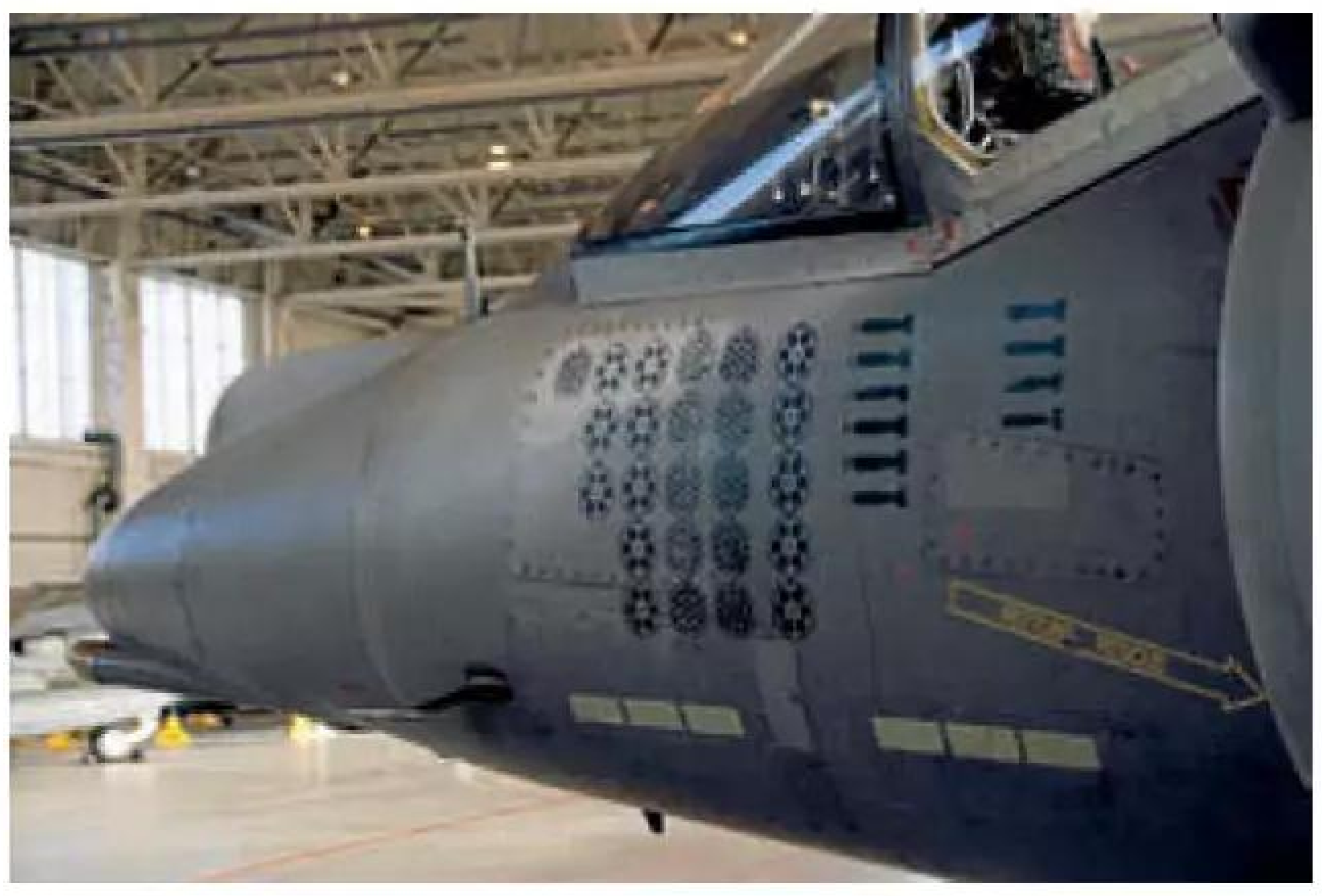
With the line comprehensively covered (ice-wise and photographically!) the next port of call was 1 (F) Squadron. After some brief negotiations, and a ‘briefing’ from the Squadron ‘Auntie’, we were allowed around their hangar. A number of veterans from the Squadron Association were also in attendance and they were more than happy to pose and pass on their personal memories (including flying a Hunter through Tower Bridge – an urban myth that appears to have some truth in it...).

Many of the Harriers here had multiple mission markings on the nose, a sign of the aircraft’s time in Afghanistan before the Tornados replaced them in 2009. The hangar also carried some ‘booty’ from the other side of the world, namely the Falkland Islands with several pieces of memorabilia placing us at ‘Base Aerea Militar Malvinas’.

A plan to have lunch in the Officers’ Mess was hijacked with confirmation ➤



The fin of the 1 Squadron Anniversary marked ZG477. **Joe Walsh**


Many of the Wittering aircraft also carried battle honours, in this case rocket and bomb sortie markings from Afghanistan. **Joe Walsh**

Last light, last look, last handshake. A frankly criminal waste. **Joe Walsh**

One of the specially marked 4 Squadron aircraft. Wg Cdr Jessett's ZD330. **Joe Walsh**

that three Wittering-based Harriers had just launched and further sorties were planned for the afternoon. So, after a flash mob of photographers had raided an unsuspecting NAAFI for sandwiches, we were handed over to Lieutenant Jim Dale RN for the afternoon and we set sail for the home of the Harrier with high hopes and a powder blue sky.

Suitably refreshed en route and checkedin at the Wittering guardroom, the next decision was where to head for the best photographs. Jim thought we'd want to be as close to the action as possible and headed to the northern side of the airfield where four aircraft were waiting to take-off. We were close, but the strong, low sun was too obtrusive and after watching an ear shattering series of departures, we relocated to the edge of the southern taxiway, adjacent to Wittering's compact flightline.

After a wait of an hour or so, and the elements actually working together for once, the first of the returning 4 (R) Squadron Harriers were sighted in echelon starboard formation. Halfway along the runway, the formation broke and the aircraft then carried out a number of circuits and bumps for the next 15 minutes or so – all bathed in the most beautiful winter sun.

As the final aircraft taxied in and shut down, the remaining four Harriers appeared in the distance in 'diamond four' formation having been on a tour of Harrier-related locations to the south. Breaking into the circuit as they passed, the pilots repeated the sequence of missed approaches, using the runway and ski jumps for take-offs, hovering in pairs against a stunning red sky until, at 1526 hours, Harrier T.10 ZH659/107, touched down on the Wittering runway for the final time, ending the station's 41-and-ahalf-year reign as the 'home of the Harrier'.

What was apparent as each of the jets taxied past and was marshalled in to shutdown, all of the pilots involved in the day's flying knew that this really was the end, shaking hands and congratulating fellow 'jocks' and the groundcrew with tremendous pride and verve before debriefing as they headed for the warmth of the squadron crewroom for one last time.

While that was it for us, the only thing that remained was for the airworthy jets to make the short transit to Cottesmore the following day. Over the next few days, the weather held off for the planned 16-ship formation to be rehearsed and flown officially to mark the very end of operations on December 15. ■ *Words: Joe Walsh*

A four-ship of 4 Squadron Harriers arrived back at Wittering otter a tour of Harrier sites. **Joe Walsh**

4 Squadron practice take-offs and landings. the last time this kind of activity was to be seen at Wittering. **Joe Walsh**

DISCOVER THE WORLD OF AVIATION PROJECTS

Building
Concorde
FROM DRAWING BOARD TO MACH 2
TONY BUTTLER WITH
JEAN-CHRISTOPHE CARBONEL

£9.99

SECRET COLD WAR DESIGNS
US STEALTH
FIGHTER PROJECTS
SCOTT LOWTHER

£11.99

US AVIATION SECRET PROJECTS
1
SR-71 BLACKBIRD
SCOTT LOWTHER

£9.99

WESTLAND
SECRET PROJECTS
Illustrated
JEREMY GRAHAM
EX-WESTLAND HEAD OF AVIONICS AND SYSTEMS TECHNOLOGY
&
RON SMITH
EX-WESTLAND HEAD OF FUTURE PROJECTS

£9.99

To view the full collection, simply visit:
shop.kelsey.co.uk or call +44(0)1959 543747
Hotline open Monday to Friday 8.30am-5.30pm. Calls charged at your standard network rate.

MILITARY GUIDES & SPECIALS
for the enthusiast

£9.99
AVIATION IN PROFILE 1
USAF FIGHTERS
DETAILED AIRCRAFT DEVELOPMENT HISTORIES
SERVICE MARKINGS FROM 1947 TO THE PRESENT
INCLUDES FAMOUS AIRCRAFT AND COLOUR SCHEMES

£9.99
More than 150 unique and expertly drawn colour profiles
AIR NATIONAL GUARD JET FIGHTERS
DECADE BY DECADE HISTORY OF THE AIR GUARD
SERVICE MARKINGS FROM 1947 TO THE PRESENT
INCLUDES FAMOUS AIRCRAFT AND COLOUR SCHEMES

£8.99
More than 150 unique and expertly drawn colour profiles
CENTURY SERIES FIGHTERS
AIRCRAFT DESIGNS BY MADS BANGSØ
DETAILED AIRCRAFT DEVELOPMENT HISTORIES
SERVICE MARKINGS FROM 1954 TO 2004
INCLUDES FAMOUS AIRCRAFT AND COLOUR SCHEMES

£9.99
MORE THAN 150 UNIQUE AND EXPERTLY DRAWN COLOUR PROFILES
FRENCH COMBAT JETS
DETAILED AIRCRAFT DESIGNS BY JP VIEIRA
SERVICE MARKINGS FROM 1952 TO THE PRESENT
INCLUDES FAMOUS AIRCRAFT AND COLOUR SCHEMES

£11.99
More than 200 unique and expertly drawn colour profiles
LUFTWAFFE BOMBERS
GERMAN WW2 DESIGNS BY CLAES SUNDIN
COLOURS AND MARKINGS FROM 1939 TO 1945
INCLUDES THE TOP LUFTWAFFE CREWS' AIRCRAFT

£9.99
MORE THAN 150 UNIQUE AND EXPERTLY DRAWN COLOUR PROFILES
MODERN AEROBATIC TEAMS
DETAILED AIRCRAFT DESIGNS BY JP VIEIRA
LIVERIES & MARKINGS FROM 1950 TO THE PRESENT
INCLUDES FAMOUS AIRCRAFT AND COLOUR SCHEMES

£9.99
More than 150 unique and expertly drawn colour profiles
US JET FIGHTERS IN FOREIGN SERVICE
DETAILED AIRCRAFT DESIGNS BY JP VIEIRA
EXPORT HISTORIES FOR 20 DIFFERENT AIRCRAFT TYPES
INCLUDES FAMOUS AIRCRAFT AND COLOUR SCHEMES

£11.99
MORE THAN 200 UNIQUE AND EXPERTLY DRAWN COLOUR PROFILES
GERMAN FIGHTERS OF THE GREAT WAR
RONNY BAR PROFILES
INCLUDES THE TOP GERMAN ACES' AIRCRAFT

£9.99
More than 120 unique and expertly drawn colour profiles
PANZER
GERMAN WW2 DESIGNS BY CLAES SUNDIN
TANK SPECIFICATIONS AND MILITARY HISTORIES
COLOURS AND MARKINGS FROM 1939 TO 1945
INCLUDES THE TOP PANZER ACES' TANKS

To view the full collection, simply visit:

mortonsbooks.co.uk or call +44(0)1507 529529

Hotline open Monday to Friday 8.30am-5.00pm. Calls charged at your standard network rate.